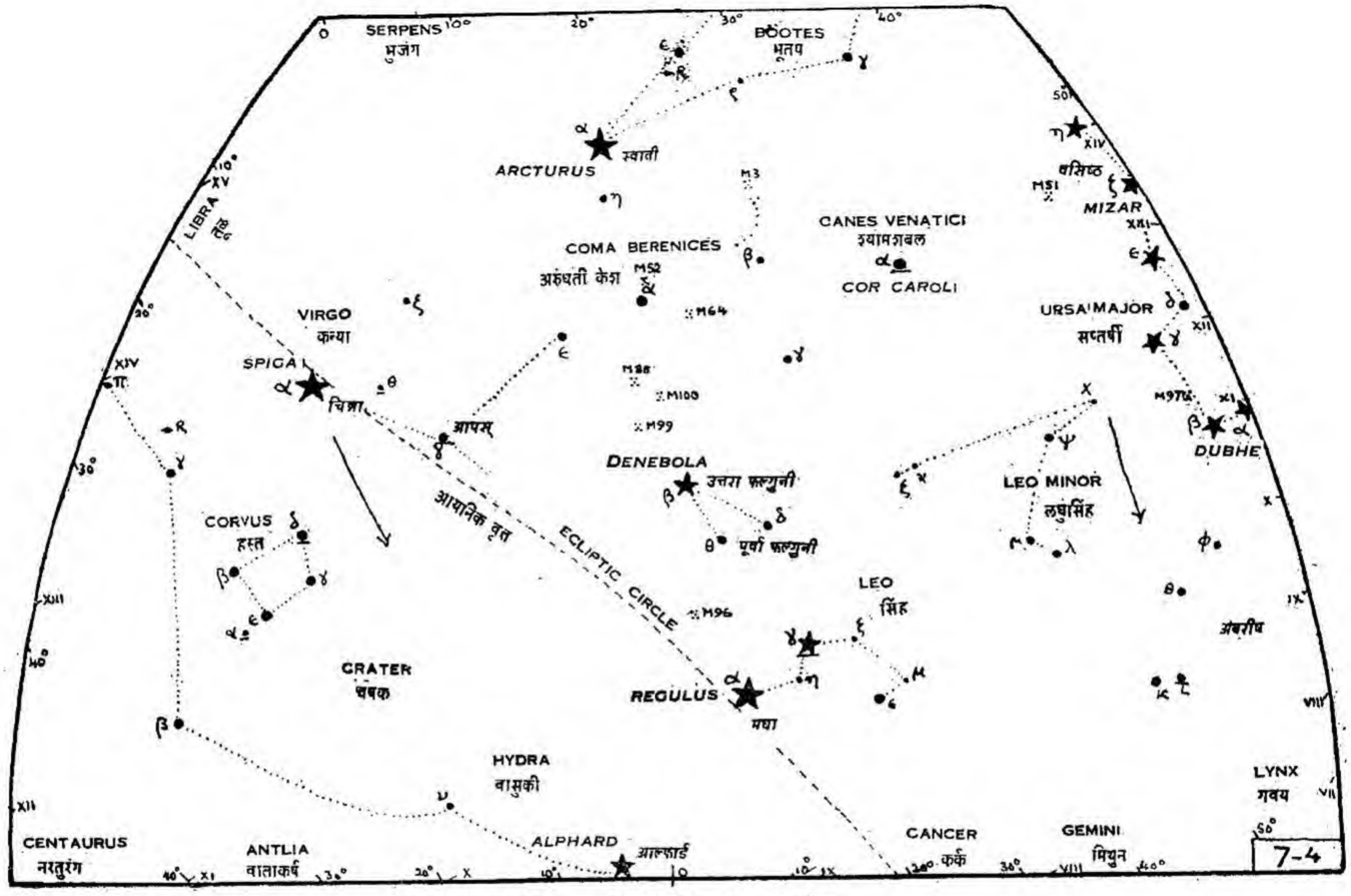


Observer's Latitude : 25°N

JULY
WEST
KEY-MAP

March	1 at 5 a. m. (I. S. T.)	March	15 at 4 a. m.
April	1 at 3 p. m.	April	15 at 2 a. m.
Jnne	1 at 11 p. m.	June	15 at 10 p. m.
July	**1 at 9 p. m.**	**July**	**15 at 8 p. m.**
August	1 at 7 p. m.	August	15 at 6 p. m.

JULY : WESTERN SKY

Prominent Stars :

- α in Boötes (Arcturus).
- α in Canes Venatici (Cor Caroli).
- α in Coma Berenices.
- α in Hydra (Alphard).
- α in Leo (Regulus), lies on the Ecliptic.
- β in Leo (Denebola).
- α in Virgo (Spica), lies on the Ecliptic.

Double Stars :

- δ, μ in Boötes, companions fainter than the main by 2 or 4 magnitudes. Seen with field-glasses.
- α in Canes Venatici, relatively fixed. Seen with a 5 cm. telescope.
- δ in Corvus, magnitudes 3.0 and 3.5. Main star is yellow.
- δ in Leo, orbital period 619 years, seen through a 5 cm. telescope.
- ζ in Ursa Major (Mizar) and Alcor seen with naked eyes.
- γ in Virgo, 2 equally bright components, for a 5 cm telescope.

Nebulae and Star Clusters :

- M 3 (NGC 5272) in Canes Venatici, under star 25, open brilliant cluster seen with naked eyes.
- M 53 (NGC 5024) in Coma Berenices, above star 42, seen with field-glasses.
- M 100 (NGC 4321) in Coma Berenices, south of star 11, seen with field-glasses.
- M 96 (NGC 3368) in Leo, between α and β. Spiral Nebula seen with field-glasses.

* * *

Some Beautiful Views of Nebulae

Fig. 7.6 : Nebulae E, F, G1, G2, G3.

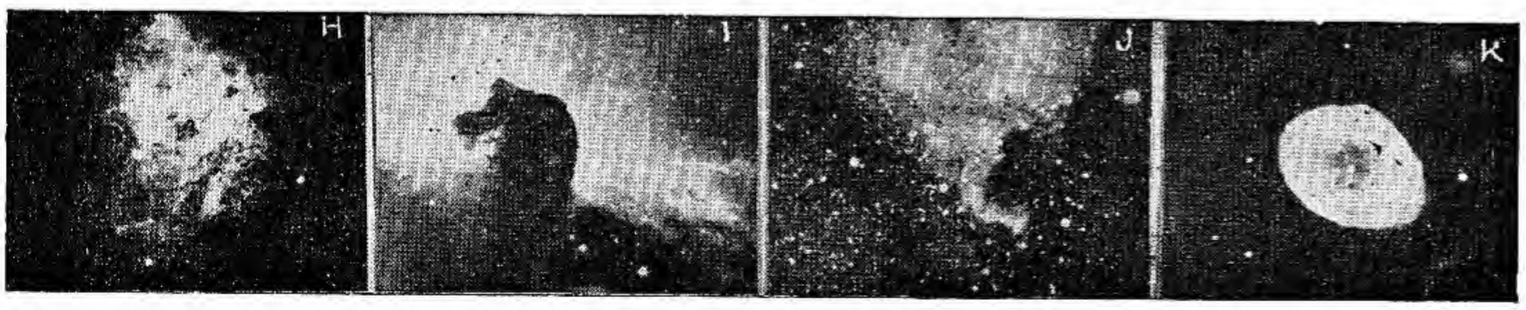


Fig. 7.7 : Nebulae H, I, J, K

E. Filamentary Nebula NGC 6960 in Cygnus.

F. Scattered Nebulae of similar shapes.
White one is NGC 6995 in Cygnus.
The other one is dark.

Three Planetary Nebulae,

G 1 Nebula NGC 1501 in Camelopardus.

G 2 Owl Nebula M 97 in Ursa Major.

G 3 Saturn Nebula NGC 7009 in Aquarius.

H. Scattered Nebulae M 8 in Sagittarius.

I. Horse's Head Nebula, Bernard 33 near ζ in Orion (500 cm telescope)

J. North America Nebula NGC 7000 in Cygnus

K. Ring Nebula (Planetary) M 57 in Lyra.

* * *

Observer's Latitude : 25° N

JULY
ZENITH
NIGHT-SKY

March	1	at	5 a. m. (I. S. T.)
April	1	at	3 p. m.
June	1	at	11 p. m.
July	**1**	**at**	**9 p. m.**
August	1	at	7 p. m.

March	15	at	4 a. m. (I. S. T.)
April	15	at	2 a. m.
June	15	at	10 p. m.
July	**15**	**at**	**8 p. m.**
August	15	at	6 p. m.

Nebulae

A NUMBER of luminous cloudy patches are seen with the naked eye in different parts of the night sky. Even when they are seen with a small telescope, they appear to be hazy and diffuse spots and as such they are clearly distinguishable from the stars. These spots are called Nebulae and it is now known that they are of two kinds.

There are true gas nebulae consisting of clouds of enormous size, and comprising of glowing gas. These are members of our galaxy, the Milky Way.

The other kind of nebulae or luminous clouds, which are far away from us, are not members of our galaxy and as such they are described as extra-galactic or merely as " Galaxies ". The nebulae of the second kind are in reality a very large collection of stars, forming among themselves separate galaxies and as such have nothing to do with our galaxy the Milky Way.

Owing to enormous distances of the extra-galactic nebulae, they appear as merely diffuse patches of light, even through very powerful telescopes. There are, however, some nearer galaxies, like the Nebula in Andromeda, whose structure can be visualised and in which even some individual stars can be located. Andromeda is, therefore, often described as an Island Universe. It resembles the Milky Way and it has been possible to draw inferences regarding the shapes of these distant and separate galaxies.

The Great Orion Nebula is a good example of a gaseous nebula in our own galaxy. In astronomical terms, it is also near us, being only 1300 light-years away. Its diameter is about 100 light-years and its mass about 10 solar masses.

The Nebulae or Galaxies can have different shapes, as revealed by the photographs taken with very powerful telescopes. Some are spiral and some are elliptical. The spiral nebulae can have many arms.

Gaseous Nebulae are classified according to their apparent shapes as Ring Nebula, Planetary Nebula or Diffuse Irregular Nebula. The appearance of a Planetary Nebula is like that ot a planet, having a uniform bright disc.

Below are some examples of the different kinds of Nebulae.

Beehive : M 44 (NGC 2632) in Cancer, known as Praesepe (seen with low power tılescope)

Coal Sack : dark regions near Crux.

Crab : M 1 (NGC 1952) in Taurus near ζ.

Dumb-bell : : M 76 (NGC 650) in Perseus,
M 27 (NGC 6853) in Vulpecula.

Great : M 42 (NGC 1976) in Orion (visible to naked eyes),

Horse's Head : (Bernard 33) in Orion near star ζ.

Horse-Shoe (*Omega*) M 17 (NGC 6618) in Sagittarius.

Keyhole : NGC 3372 in Carina near η.

North America ; (NGC 7000) in Cygnus.

Owl : M 97 (NGC 3587) In Ursa Major (low power telescope).

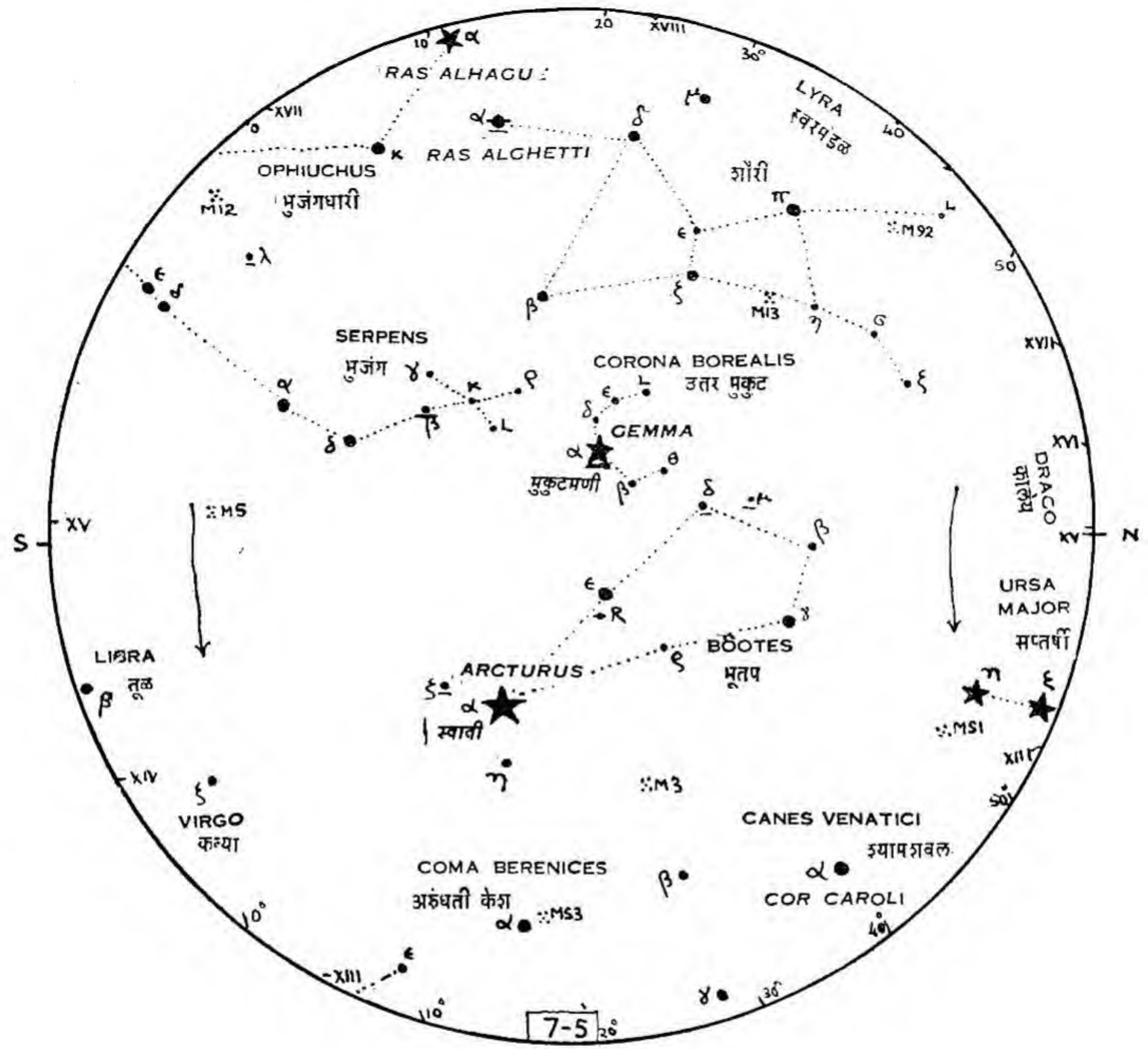
Planetary : NGC 6543 in Draco near the Pole of the Ecliptic.
NGC 2440 in Puppis.

Ring : M 57 (NGC 6720) in Lyra.

Saturn : NGC 7009 in Aquarius.

(For illustrations of some of these Nebulae see figure 7.4 on page 145 and figures 7.6, 7.7 on page 149)

* * *



Observer's Latitude : 25° N

March	1	at	5 a. m. (I.S.T.)
April	1	at	3 p. m.
June	1	at	11 p. m.
July	**1**	**at**	**9 p. m.**
August	1	at	7 p. m.

JULY
ZENITH
KEY-MAP

March	15	at	4 a. m. (I. S. T.)
April	15	at	2 a. m.
June	15	at	10 p. m.
July	**15**	**at**	**8 p. m.**
August	15	at	6 p. m.

Double Stars

SIRIUS IN the night sky is one of the brightest stars. It is α in Canis Major. It is not a single star, but it has a companion. These two stars are going round each other continuously. Seen with the naked eye it does appear single but seen through a telescope we see that the companion is separated from the main. When stars revolve round each other about their common centre of gravity, they are called multiple stars.

ζ or Mizar in Ursa Major is such a multiple star. The principal star α in Centaurus and α in Ursa Minor, the Pole Star, are also multiple stars.

Castor and Pollux (α and β in Gemini) are easily identifiable in the Milky Way. Out of these two, Castor is really a wonderful multiple star. There is another important thing about this pair. Although we regard them both as belonging to the same constellation, they are not so. There is nothing physically common between them.

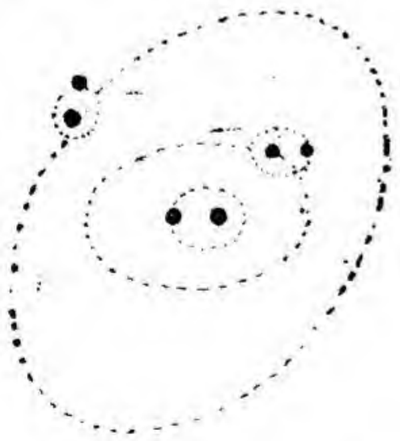


Fig. 7.8 Multiple Star Castor

Castor is a multiple star in as much as it is now known to be really six stars linked with each oher as a system. It was known for a very long time that Castor had a companion and seen through a small telescope the companion does appear separated from the main. Both of these stars are extremely hot and they are called white stars. They revolve round their common centre of gravity and the period of revolution is 380 years. Seen through a modern high power telescope, each of Castor's companions shows itself to be a double star. These twins revolve round each other very fast in 9 and 3 days. Being a quadruple multiple star is not enough. Now it is also known that there is another faint and red-coloured partner. There is ample evidence to show that this red partner actually belongs to the Castor complex, and that it goes round Castor in 1000 years. It is further revealed that this red companion is itself a double and the period of revolution of this pair is less than a day. It can be seen thus that Castor consists of *six* separate stars, and all the three pairs revolve round each other about their common centre of gravity.

Some multiple stars cannot be resolved even by the most powerful telescopes so far available. Their multiple character can be recognised only by a spectroscopic examination. Such stars are called spectroscopic binaries.

* * *

Gnomon

THIS IS an instrument, used since ancient times, to measure the elevation of the Sun. In its simplest form, it consists of an upright rod or a pillar. The Sun's elevation is easily found from, the length of the rod and the length of its shadow. The arm of a sundial is still known as a ' gnomon. '

* * *

Observer's Latitude : 25° N

AUGUST NORTH NIGHT-SKY

April	1 at 5 a. m. (I. S. T.)	April	15 at 4 a. m. (I. S. T.)
May	1 at 3 a. m.	May	15 at 2 a. m.
July	1 at 11 p. m.	July	15 at 10 p. m.
August	**1 at 9 p. m.**	**August**	**15 at 8 p. m.**
September	1 at 7 p. m.	September	15 at 6 p. m.

Lyra

LYRA IS a northerly constellation. It can be seen in the Northern sky, in the month of August, at about 8 p.m. well above the horizon and on the left side of the Milky Way. Its brightest star α is Vega above the horizon. It can be seen in the mornings in January and in the evenings in June. Vega is called *Abhijit* (अभिजित) and it is of magnitude 0.1, about 60 times brighter than the sun and about 27.5 light-years away from us.

On the 19th and 20th April swift meteors, known as *Lyrids* radiate from the vicinity of Lyra and give an interesting display.

According to a Greek legend, the Lyra is a celestial harp hung around the neck of an eagle and its appearance in the heavens brings to mind the story of the beautiful lovers, Orpheus and Eurydice.

According to *Mahābhārata, Abhijit* (अभिजित) was the younger daughter of *Rohiṇī* (रोहिणी). She wanted to be the elder one and therefore she went away to do penance. In this manner one constellation came to be removed and that created a problem in the reckoning of time. When *Rohiṇī* (रोहिणी) became the first *Nakṣatra* (नक्षत्र) it was, according to present day calculations, a period prior to 3000 B.C.

There are two faint stars ε and ζ near Vega. With γ and β (Sulaphal and Sheliak respectively) a rhombus is formed. ε is on its northern side and it is a double, visible to the naked eye. Seen through a small telescope it is a group of 5 stars. The star β is a reprsentative eclipsing binary. It is now known that β is a group of six stars. Near the star β can be seen, through a telescope, the famous Ring Nebula M 57 (NGC 6720) with a star in the centre and a bright ring surrounding it.

The solar system is moving towards the constellation Lyra with a speed of about 19 Km. per second. Travelling with this speed, it would take us approximately 3 months to reach the Sun ! Furthermore, if Vega remains where it is at present, the Sun would get there in about 500,000 years !!

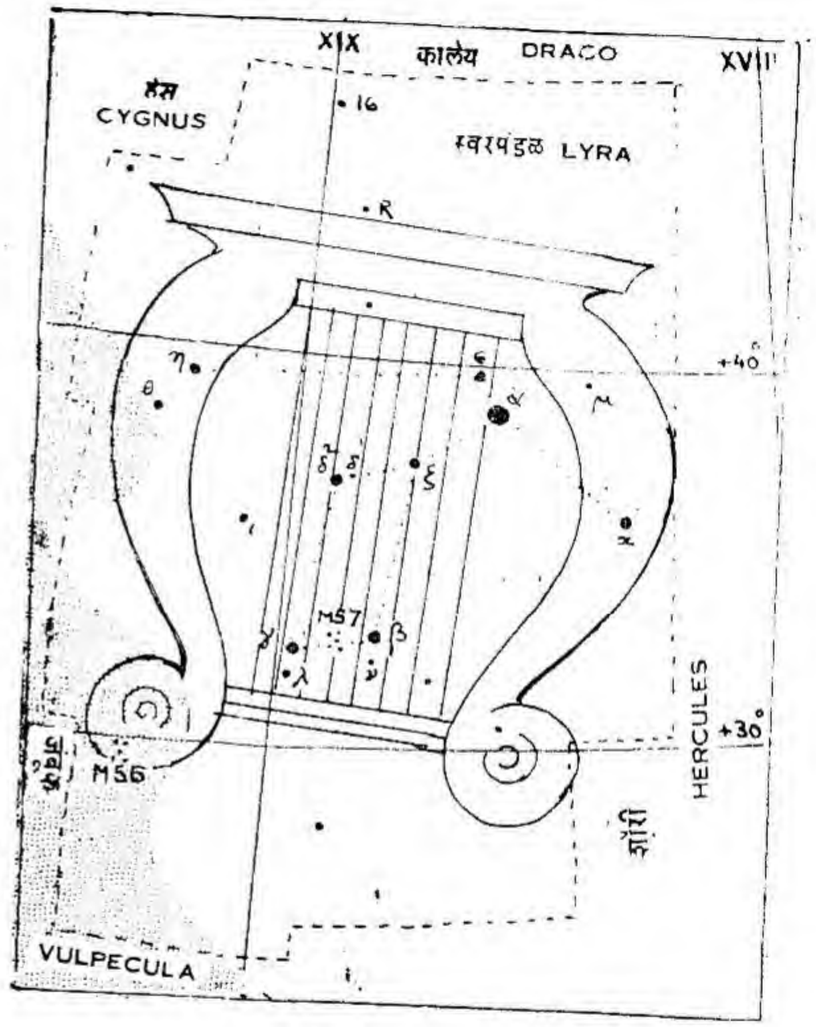
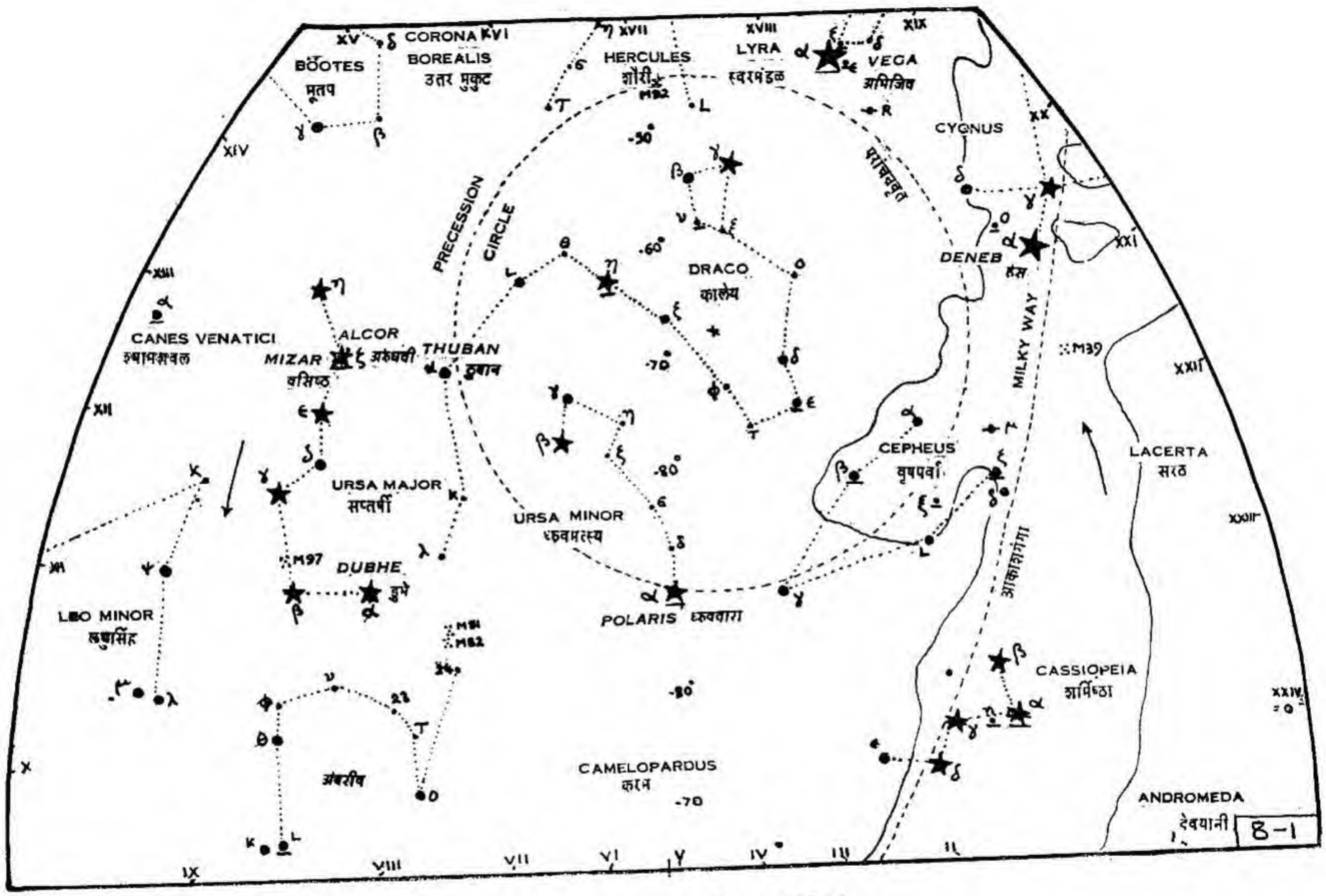


Fig. 8.1 : Lyra

* * *

Sun appears red at sunrise and at sunset

NEAR SUNSET or sunrise, the sun's rays, slanting through a long atmospheric path have nearly all the blue light scattered out of them. Consequently, there is only red and yellow light left is the direct beams, hence this red colour of the sun's disc. Further, such light as illuminates the clouds is also mainly of this colour.



Observer's Latitude : 25° N

AUGUST
NORTH
KEY - MAP

April	1 at 5 a. m. (I. S. T.)	April	15 at 4 a. m. (I. S. T.)
May	1 at 3 a. m.	May	15 at 2 a. m.
July	1 at 11 p. m.	July	15 at 10 p. m.
August	**1 at 9 p. m.**	**August**	**15 at 8 p. m.**
		September	15 at 6 p. m.

AUGUST : NORTHERN SKY

Prominent Stars :

β in Cassiopeia lies near the Zero Hour-Angle circle,
Five bright stars of Cassiopeia form the letter M or W.

α in Cygnus (Deneb).

α in Draco (Thuban). Pole Star in ancient times.

α in Lyra (Vega), Pole Star of the future.

α, β in Ursa Major (the Pointers).

ζ in Ursa Major (Mizar) with its neighbour (Alcor).

α in Ursa Minor (Polaris). Pole Star in present times.

Double Stars :

η in Cassiopeia, seen with a 5 cm. telescope.

β, ζ in Cepheus, seen with a 5 cm. telescope.

β, μ, o_2 in Cygnus, seen with a field-glass,
o_2 in Cygnus is a triplet.

ν in Draco. 2 equally bright 5th. magnitude stars, seen through a binocular.

ε, η in Draco. Components of different brightness seen with a 7.5 cm. telescope.

α in Lyra. Optical pair 56″ apart. 0.2 and 10.5 magnitudes.

ε in Lyra. Wide double 208″ apart, visible to naked eyes.

ζ, β in Lyra. Wide pairs. Seen through a binocular.

η in Lyra. 3 small pairs seen in a low power field-glass.

ζ in Ursa Major. This has a companion Alcor 11′ away.
ζ (Mizar) itself is a double, seen through a 5 cm. telescope.

α in Ursa Minor.
Wide double, seen with a 5 cm. telescope.

Variable Stars :

δ in Cepheus; regular period of 3.37 days.

α in Hercules; variation from 3.1 to 3.9 magnitudes.

β in Lyra; representative of a class; period 12.91 days.

Nebulae and Star Clusters :

M 13 (NGC 6205) in Hercules, between η and ζ. Seen with naked eyes.

M 92 (NGC 6341) in Hercules beyond π, in line with α, δ, π seen with naked eyes.

M 39 (NGC 7092) in Cygnus, beyond α, near π^2.
In Cygnus there is a strong source of radio emission.

M 57 (NGC 6720) 'Ring Nebula' in Lyra, about half-way on the line connecting β and ν, seen only through a telescope.

M 97 (NGC 3587) in Ursa Major, between β and γ, "Owl Nebula". Seen with a low power telescope.

* * *

The Sky appears Blue by Day

AT NIGHT the sky appears dark during the absence of the moon, but during the day the sky appears blue. This appearance is due to the fact that the Earth's atmosphere scatters blue light more than the red light. The scattered light for any sunbeam is, therefore, predominantly blue. Consequently, when the eye looks in a direction away from the sun, it sees only this blue light scattered from the general sunlight reaching the earth in the neighbourhood of the observer.

* * *

Observer's Latitude : 25° N

AUGUST
EAST
NIGHT-SKY

April	1 at 5 a. m. (I. S. T.)	April	15 at 4 a. m. (I. S. T.)
May	1 at 3 a. m.	May	15 at 2 a. m.
July	1 at 11 p. m.	July	15 at 10 p. m.
August	**1 at 9 p. m.**	**August**	**15 at 8 p. m.**
September	1 at 7 p. m.	September	15 at 6 p. m.

Aquila

DURING THE month of August, in the south-west corner of the sky and well above the horizon, Aquila can be seen just below the Milky Way.

Aquila is figured as a flying eagle. According to Greek mythology, an eagle was sent to seize a beautiful youth by name Ganymede. This eagle was rewarded for its daring flight by being placed among the constellations. Hence the name Flying Eagle or Aquila.

There are 3 bright stars and the brightest of them is ω, It is called Altair, because in Arabic this word means the Flying Eagle. Altair has a magnitude 0.9. It is about 10 times brighter than the sun and its distance is about 16 light-years. Other stars are β (Al shain) and γ (Venatore).

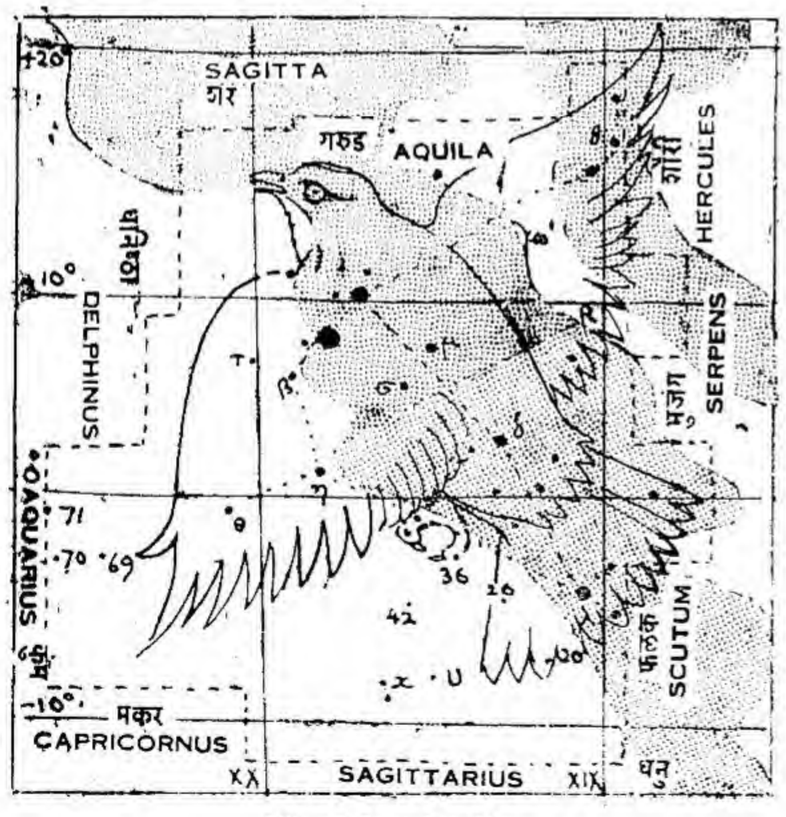


Fig. 8.2 : Aquila

Indian mythology has a similar story of the Flying Eagle. *Garuda* (गरुड) the eagle, was held in bondage by the *Nāgās* (नाग Snakes) who desired to possess *Amṛta* (अमृत nectar). Garuda, therefore, undertook to secure the *amṛta* from the Gods. He fought with the Gods and *Indra,* (इंद्र) secured the pots containing the nectar and obtained its freedom from bondage.

The constellation, as it appears, has the shape of a rhombus. Altair, the brightest star, occupies one corner. It has two neighbours, one on either side, known as Al shain and Tarazed. These three stars make what is known as the "Shaft of Altair."

Altair is one of the nearest of the brightest stars and it is approaching the solar system at the rate of about 32 km. per second. It is so far away from us that any appeciable increase in its brightness will not be noticeable for thousands of years.

A Nova had appeared in this constellation in the year 1918 A.D. It had reached a brightness of −0.2 magnitude and appeared almost as bright as Sirius (α in Canis Major) and Canopus (α in Carina). Normally this star is only of 11th. magnitude and it is about 1,100 light-years away from us.

In the southern part of Aquila, η is a famous variable star. It has a period of 7.18 days and a variation from 3.7 to 4.5 magnitudes. This star is about 16 light-years away from us. During its variation, its radius, which is about 35 times greater than that of the sun, increases and decreases through 5/100th. This variable star is classified as belonging to the Cephied type.

A meteoric shower, with its radiant at 5° to the east of Altair, is seen from 7th June 12th August.

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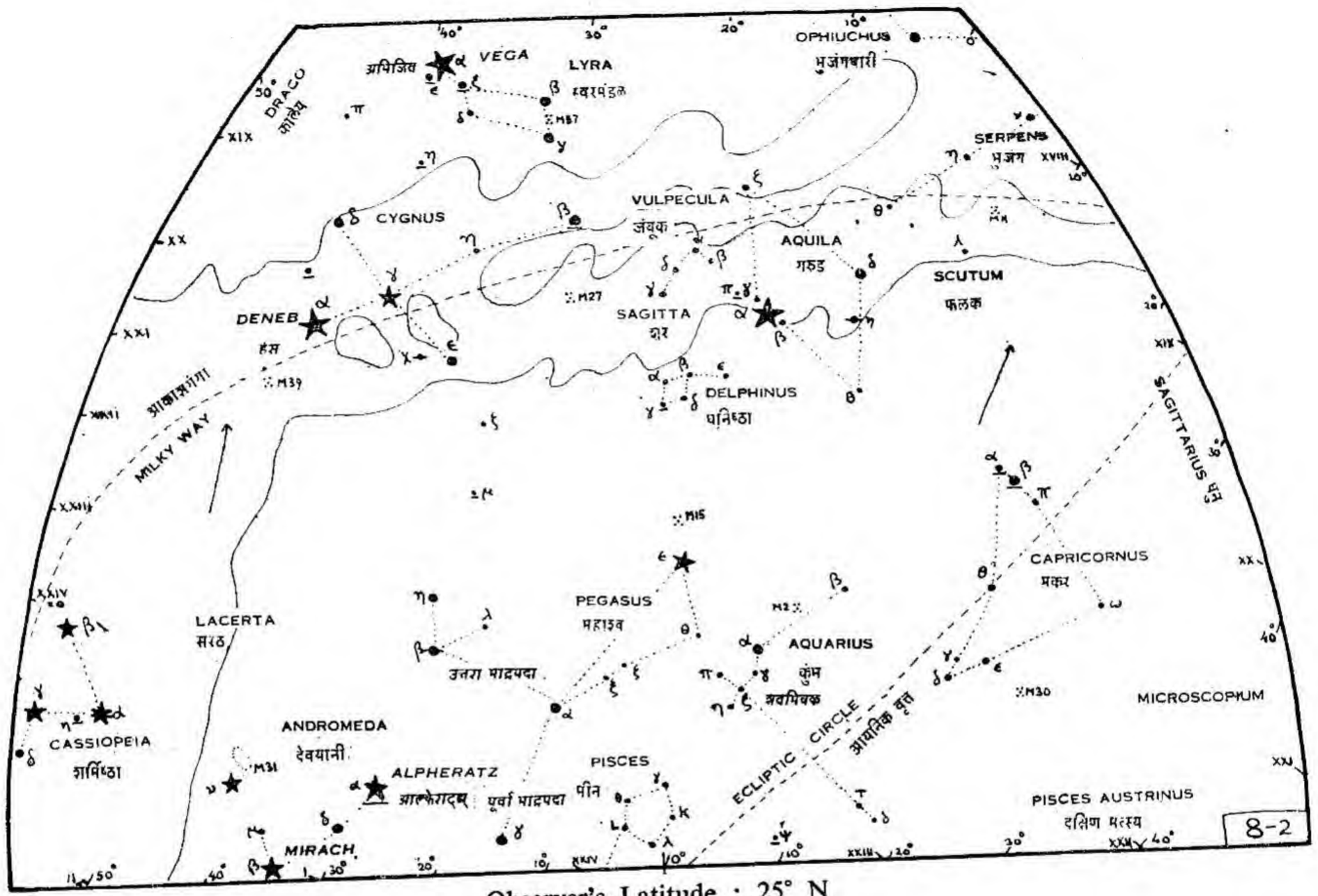

Observer's Latitude : 25° N

AUGUST
EAST
KEY-MAP

April	1 at 5 a. m. (I. S. T.)
May	1 at 3 a. m.
July	1 at 11 p. m.
August	**1 at 9 p. m.**
September	1 at 7 p. m.

April	15 at 4 a. m. (I. S. T.)
May	15 at 2 p. m.
July	15 at 10 p. m.
August	**15 at 8 p. m.**
September	15 at 6 p. m.

AUGUST : EASTERN SKY

Prominent Stars :

α in Andromeda (Alpheratz).

α in Aquila (Altair), known since 1000 B.C.

α in Capricornus (Giedi).

α in Cassiopeia (Shedar).

α in Cygnus (Deneb).

α in Lyra (Vega).

α, β in Pegasus (Markab, Sheat) near hour-angle XXIII.

Double Stars :

π in Aquila, seen with a 7. 5 cm. telescope.

β, μ, o_2 in Cygnus, seen with a field-glass.

γ in Delphinus, yellow and emerald, seen with a 5 cm. telescope.

α in Lyra, optical pair 456″ apart, 0.2 and 10.5 magnitude.

ζ, β in Lyra, wide pairs, seen through a binocular.

η in Lyra, 3 small pairs in a low power field-glass.

Star 6 in Vulpecula, between ε Cygnus and Delphinus, not shown here. Wide optical double, 400″ apart, 4.5 and 5.7 magnitude.

Variable Stars :

η in Aquila. Cephied type, period 7.18 days.

χ in Cygnus, Mira type, varies through 10 magnitudes, period 413 days.

β in Lyra, representative variable of period 12.91 days.

β in Pegasus, variation from 2.2 to 2.7 magnitudes.

Nebulae and star clusters :

M 30 (NGC 7099) in Capricornus, near ζ, globular and seen through a field-glass.

M 39 (NGC 7092) in Cygnus, beyond α near π^2. Open cluster seen through a field-glass.

In Cygnus there is a strong source of radio emission.

M 57 (NGC 6729) Ring Nebula in Lyra, almost half-way on the line connecting β and γ, seen only through a telescope. Distance = 500 parsecs = 1630 light-years.

M 15 (NGC 7078) in Pegasus near ε, globular and brilliant.

M 27 (NGC 6853) in Vulpecula; a planetary nebula, 4′ in diameter seen only through a large telescope.

* * *

Cosmogony

THIS MEANS, literally, theory of the birth of the Universe. Since the earliest times, men have formed views about the origin of the universe. The facts furnished by modern physics, astronomy and chemistry form a good basis for reasonable speculation concerning the origin and history of the universe. It is a part of the great science known as Evolution of Stars. It is in fact the development of the stars from their origin to the present day and their future possible development. (See *Evolution of the Universe* at page 133.)

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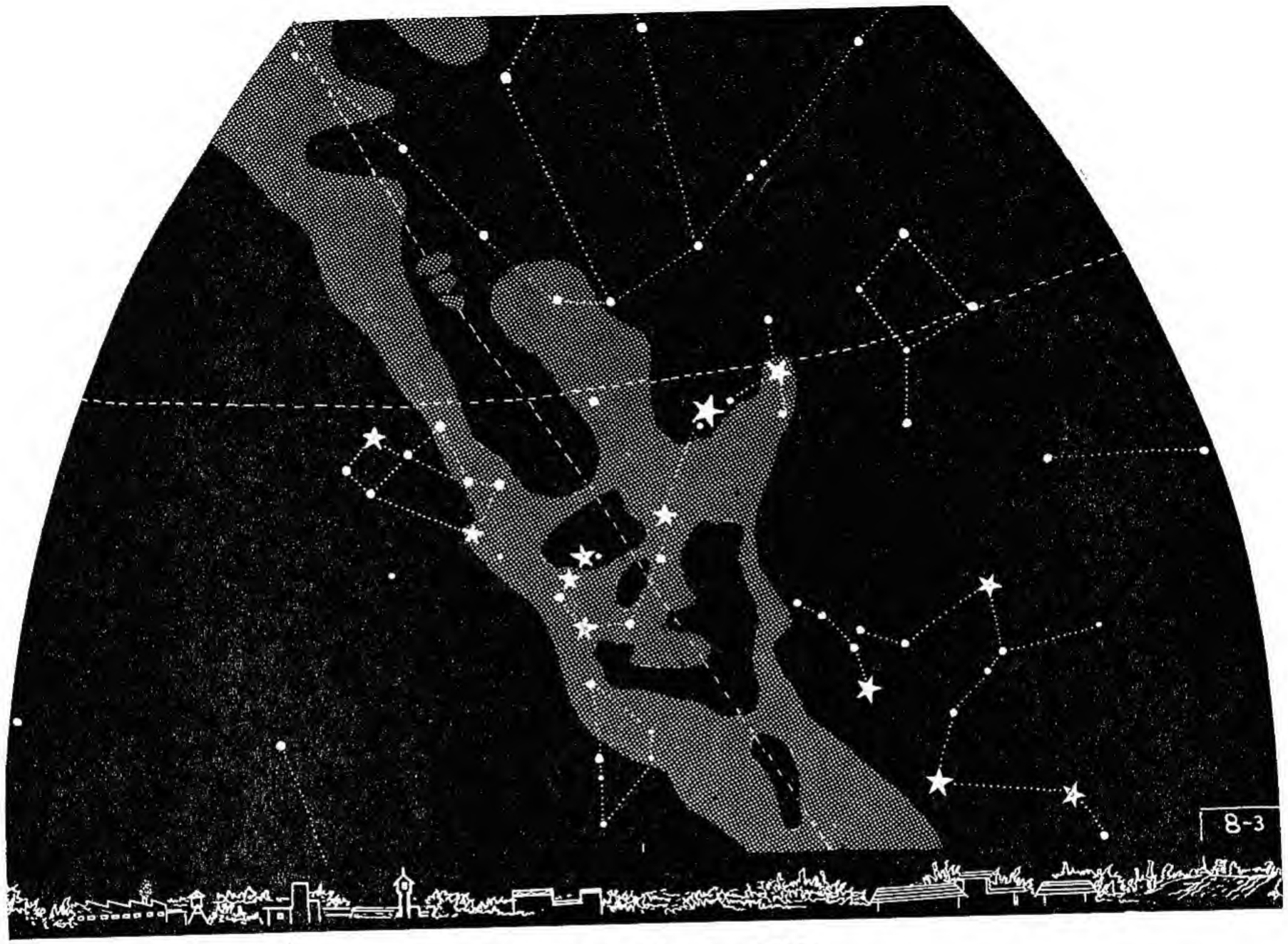

Observer's Latitude : 25° N

AUGUST SOUTH NIGHT-SKY

April	1 at 5 a. m. (I. S. T.)	April	15 at 4 a. m. (I. S. T.)
May	1 at 3 a. m.	May	15 at 2 a. m.
July	1 at 11 p. m.	July	15 at 10 p. m.
August	**1 at 9 p. m.**	**August**	**15 at 8 p. m.**
September	1 at 7 p. m.	September	15 at 6 p. m.

Sagittarius

THIS CONSTELLATION follows the Scorpion (Scorpius) at the most southerly part of the ecliptic. Here one looks towards the centre of the Milky Way, and the view is partly obscured by dark cosmic clouds.

According to Greek mythology, Sagittarius the Archer, is supposed to be a Centaur. The Centaur was a race which was supposed to possess the body of a horse and the head and shoulders of a man. One of such centaurs was called Chiron. He lived in a stone cave near Mount Pelion and was a famous tutor to a number of well known Greck heroes like Hercules, Castor and Pollux, Achilles and others.

The bright stars in the consellation can be joined in different ways to produce different figures. One such figure looks like two saucepans kept near each other. Another figure* shows the figure of a horse with its tail raised upwards. The arrow of the Centuar is directed towards the brightest star Antares of the Scorpion (Scorpius).

There are only two stars of magnitude 2 and eight stars of magnitude 3. Seen through a telescope they present a magnificent sight.

This constellation contains many star clusters. Some of them are open and some are closed. There are some beautiful nebulae and some novae.

The Milky Way that we see is really a part of our own galaxy. Its centre lies somewhere near Sagittarius, The sun occupies a place in this our galaxy about 30,000 light-years away from the centre. Our galaxy is rotating and it takes about 200 million years to complete one rotation.

While Sagittarius was considered by Greek mythology to be a Centaur in the sky, there is another Centaur contemplated for those who live further down in the southern latitudes. In India, we can see a part of this Centaur in the southern sky in the evening during the month of June. The constellation is called Centaurus. Its two bright stars α (Rukabat) and β (Arkab) are sometimes designated 'the Southern Pointers' on the analogy of the Pointers α and β in the Ursa Major of the northern sky. α and β of Centauri point towards the easily identifiable figure of the Southern Cross known as Crux.** When navigators cross the equator and enter the southern hemispnere, they employ the Southern Cross in the same manner as they employ the Pole Star in Ursa Minor in the northern hemisphere.

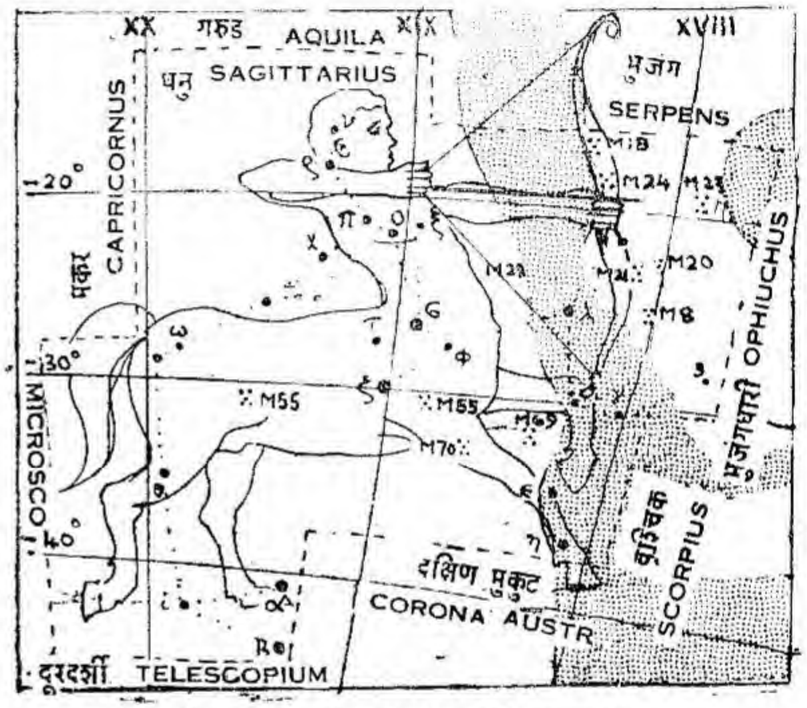

Fig. 8.3 : Sagittarius (Dhanu)

The stars δ (Kas Media), ε (Kas Australis), λ (Kas Borealis) are together known as Pūrvāṣādhā (पूर्वाषाढा) and σ (Nanki) and ζ are known as Uttarāṣādhā (उत्तराषाढा).

According to Indian mythology, Crux is called *Triśaṅku.* (त्रिशंकु).

It is also known that the constellation Cygnus, which resembles a cross is occasionally desecribed as the Northern Cross. Its resemblance with the Southern Cross is striking.

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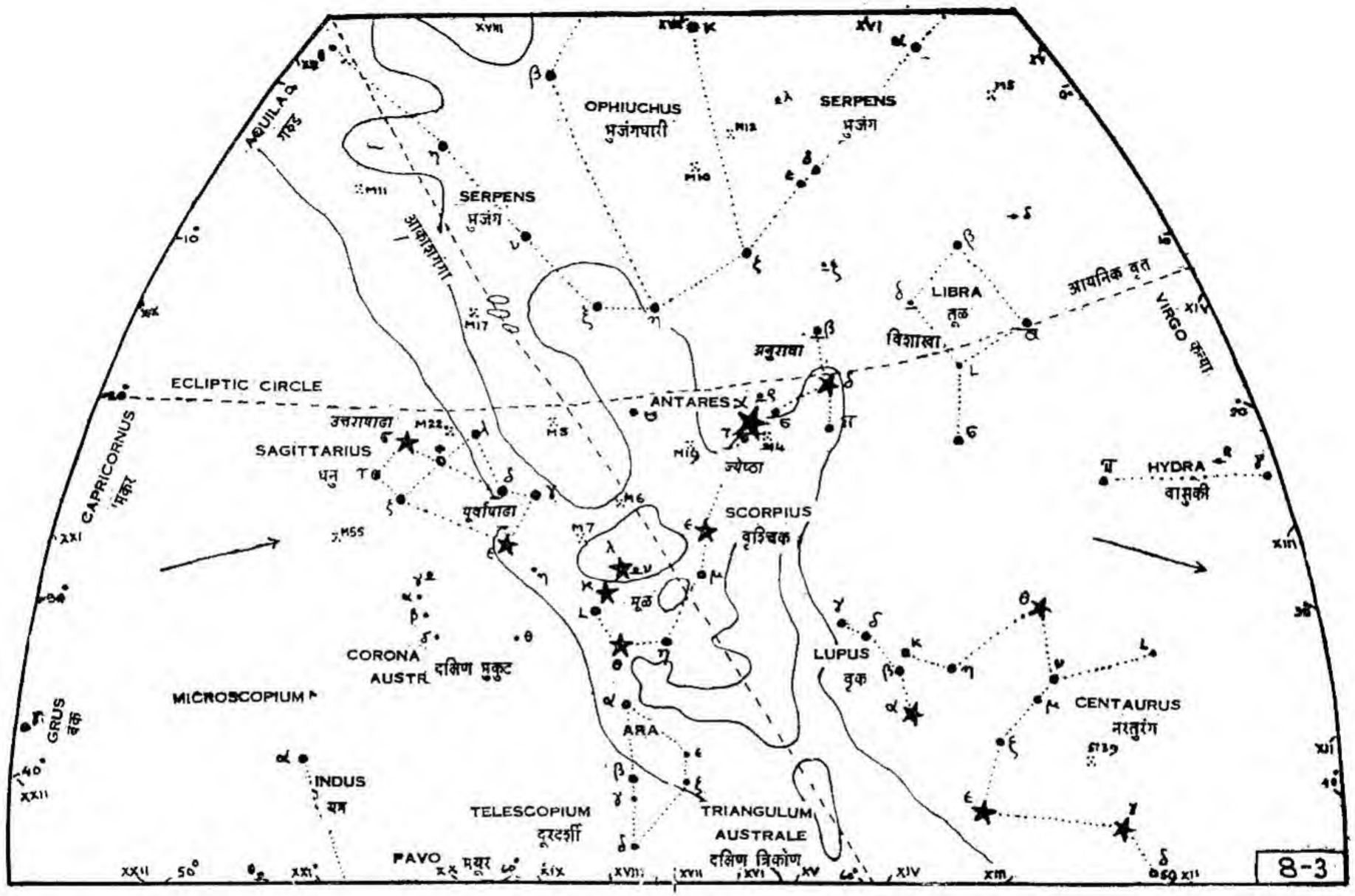
*See *Centaurus* at page 123

** See *Crux* at page 103.

* * *



Observer's Latitude : 25° N

AUGUST
SOUTH
KEY - MAP

April	1	at 5 a. m.	(I. S. T.)
May	1	at 3 a. m.	
July	1	at 11 p. m.	
August	**1**	**at 9 p. m.**	
September	1	at 7 p. m.	

April	15	at 4 a. m.	(I. S. T.)
May	15	at 2 a. m.	
July	15	at 10 p. m.	
August	**15**	**at 8 p. m.**	
September	15	at 6 p. m.	

AUGUST : SOUTHERN STARS

Prominent Stars :

α in Centaurus (Al Kentarus). Second nearest star to us.
ω in Libra (Zuben el Genuti) lies on the Ecliptic.
α in Lupus (Arneb).
α in Ophiuchus (Ras al Hague).
ε and σ in Sagittarius (Kaus Australis).
α in Scorpius (Antares).

Double Stars :

α in Centaurus, splendid binary 0.3 and 1.7 magnitudes.
α in Libra, wide double 230″ apart.
Star 70 in Ophiuchus, between η Serpens and β Ophiuchus. Yellow and red components, seen with a 5 cm telescope.
θ in Serpens (tail star), seen through a field-glass.
α in Scorpius, with a faint companion.
β, ν, σ in Scorpius, wide doublets.
ξ in Scorpius, seen through a 5 cm telescope.

Variable Stars :

δ in Libra, Algol type, 4.8 to 6.2 magnitudes.
τ in Centaurus, long period of 90 days. 5.2 to 0.3 magnitudes.

Nebulae and Star Clusters :

M 30 (NGC 7099) in Capricornus near ζ, globular, seen with a field glass.

NGC 5139 in Centaurus, looks like a tailless comet, seen with naked eyes.

NGC 6633 in Ophiuchus, near θ in Serpens, really belongs to, Ophiuchus, seen through a field-glass.

M 5 (NGC 5904) in Ophiuchus near α, bright, seen with naked eyes.
M 10 (NGC 6254) and M 12 (NGC 6218). in Ophiuchus on the line β δ
M 19 (NGC 6273) in Ophiuchus, perpendicular to line η, ζ. Fine globular cluster 5′ in diameter.
M 8 (NGC 6523) in Sagittarius, known as Lagoon Nebula, seen with naked eyes.
M 22 (NGC 6656) in Sagittarius, between σ and μ bright globular, 15' in diameter.
M 4 (NGC 6121) in Scorpius near α, bright and globular in appearance.
M 7 (NGC 6475) in Scorpius near σ (at the tail), brilliant and open, seen with naked eyes.

* * *

Green Flash

WHEN THE Sun is setting, the last remaining segment is sometimes seen to turn green ond afterwards, a flash of green light shoots up for a few seconds. This is the Green Flash. It is best seen over a sea horizon when the atmosphere is very clear, but can sometimes be seen under other conditions also. The flash is caused by atmospheric refraction of sunlight and its green colour arises because the blue light is removed by the usual atmospheric scattering, while the red light is removed by the absorption of water vapour when there is a very long path close to the water surface.

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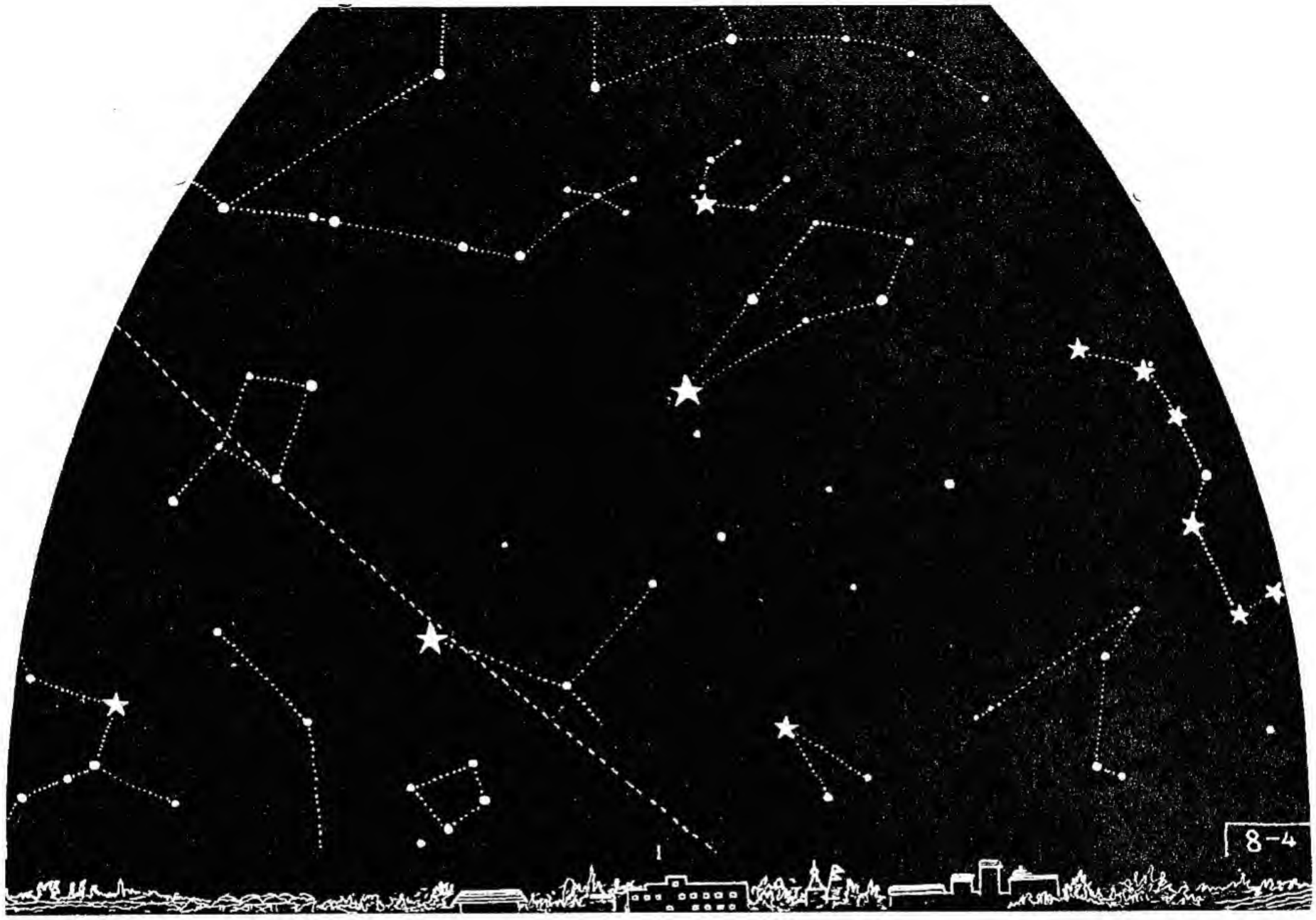

Observer's Latitude : 25° N

AUGUST
WEST
NIGHT-SKY

April	1	at	3 a. m.	April	15	at	4 a. m.
May	1	at	3 a. m.	May	15	at	2 a. m.
July	1	at	10 p. m.	July	5	at	10 p. m.
August	**1**	**at**	**9 p. m.**	**August**	**15**	**at**	**8 p. m.**
September	1	at	7 p. m.	September	15	at	6 p. m.

(I. S. T.)

Virgo

THIS CONSTELLATION lies on the Ecliptic. The Sun enters Virgo in the middle of September and comes out of it in about six weeks time. Virgo thus occupies the largest span of the Ecliptic, among the Zodiacs, covering about 44 degrees. During this period, the Sun reaches the Autumnal Equinox and moves further towards the south crossing the Equator.

In Roman mythology it was believed that successive conflagrations and deluges were designed by the Gods to purify the earth from the sins of its inhabitants. After each of these disasters man was again regenerated, so that he could live in virtue and in happiness. Mankind, however, proved somewhat ungrateful and the entire race was destroyed by Jupiter. At this stage, all the Gods and Goddesses, except one, left the earth. The one who remained behind was Astrea, the Goddess of Justice and Purity. But finally even this Goddess concealed her face in sorrow, left the earth and took her place among the stars. This is Virgo.

According to Greek mythology, one king once offered wine to some shepherds. They got very drunk and disgracefully murdered the King. Seeing this very unfortunate incident, the King's daughter was very much grieved and committed suicide. Afterwards she was raised by the Gods to sky as a constellation.

In most pictorial representations, however, Virgo is shown as a girl with long legs and running behind the Celestial Lion.

The principal star α is very bright. of magnitude 1.2. It is called Spica meaning Corn of Wheat. Arabian astronomers called this star 'the Kennel' or 'the Retreat of the Howling Dog.' The significance of this nomenclature is, however, not quite clear.

Spica is an eclipsing binary. Both the partners are comparable to each other in size, but one of them has 10 times more mass and 1000 times greater luminosity than those of the Sun, while the other has only 4.5 times the mass and 700 times the luminosity of the Sun. The period of revolution of the components round their common centre of gravity is only 4 days. Its distance from us is about 300 light-years. The star names are β (Zewijah) and ε (Vindimiatrix).

The star γ is also a double with partners of comparable size, but their magnitudes are far apart, being 2.9 and 8 respectively, the period of revolution being about 180 years. This star γ is called *Āpasa* (आपस) in Indian astronomy.

In Vedic literature, the neighbouring constellations to Virgo or *Kanyā* are represented as the huge figure of *Prajāpatī* (प्रजापती). *Hasta* (हस्त Corvus) makes the palm. *Spica* makes the head. *Viśākhā* (विशाखा) make the thighs and *Anurādhā* (अनुराधा) the steps of *Prajāpatī* and the great figure is staring at the Lion with his fists closed.

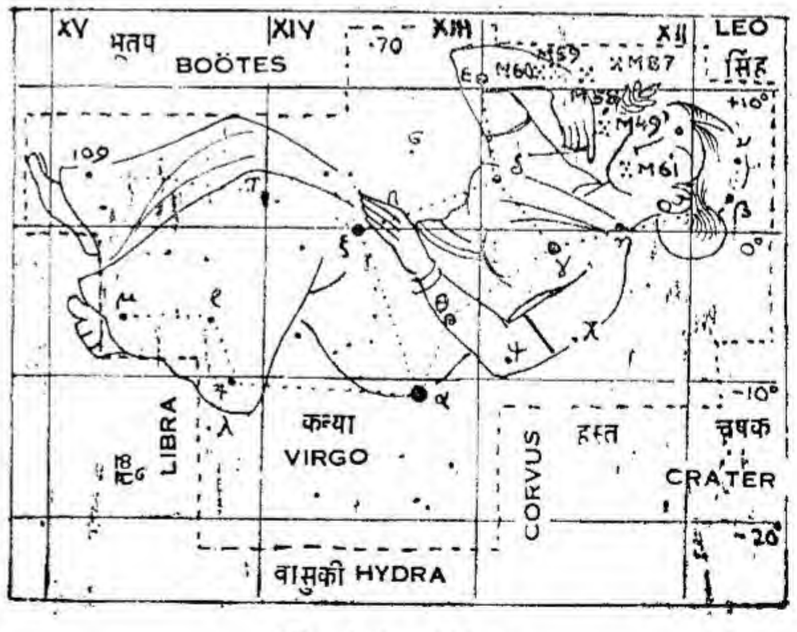

Fig. 8.4 : Virgo

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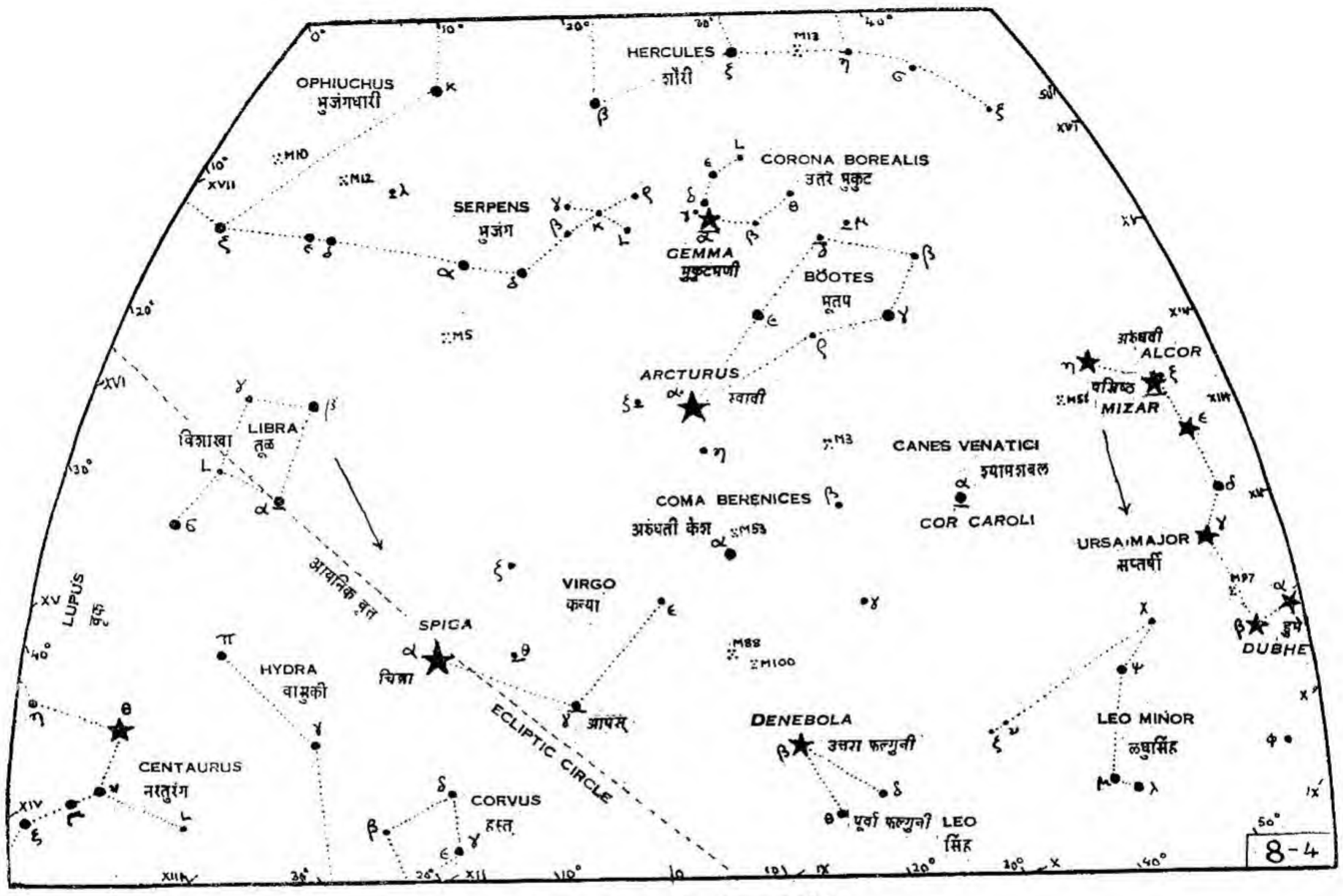

Observer's Latitude : 25° N

AUGUST
WEST
KEY - MAP

April	1	at 5	a. m.	(I. S. T.)
May	1	at 3	a. m.	
July	1	at 11	p. m.	
August	**1**	**at 9**	**p. m.**	
September	1	at 7	p. m.	

April	15	at 4	a. m.	(I. S. T.)
May	15	at 2	a. m.	
July	15	at 10	p. m.	
August	**15**	**at 8**	**p. m.**	
September	15	at 6	p. m.	

AUGUST : WESTERN SKY

Prominent Stars :

- α in Boötes (Arcturus).
- α in Corona Borealis (Gemma).
- β in Leo (Denebola).
- α in Libra (Zuben el Genuti). This lies on the Ecliptic.
- α in Virgo (Spica) This also lies on the Ecliptic.
- α, β in Ursa Major (the Pointers).
- ζ in Ursa Major (Mizar), with its neighbour (Alcor).

Double Stars :

- δ, μ in Boötes. Companions are 2 to 4 magnitudes fainter than the main star, seen through a field-glass.
- α in Corona Borealis, well-known, seen with a 5 cm. tel.scope.
- α in Libra. Wide double 230″ apart.
- γ in Virgo. Equally bright components seen with a 5 cm. telescope.
- ζ in Ursa Major (Mizar) and its neighbour Alcor.
  Mizar itself is a double, seen through a 5 cm. telescope.

Variable Stars :

- δ in Libra. Variable of the Algol type, variation from 4.8 to 6.2 magnitudes.

Nebulae and Star Clusters :

- M 53 (NGC 5024) in Coma Bercnices, above star 42, globular. Seen with a field glass.
- M 100 (NGC 4321) in Coma Berenices, south of star 11, Seen with a field glass.
- M 5 (NGC 5904) in Serpens near α. Seen with naked eyes.
- (NGC 6633 in Ophiuchus near Serpens. Seen with a fiield-glass.

* * *

Different Shapes of Galaxies.

IT IS generally assumed that a Galaxy is initially spherical in shape resembling very much an ellipsoidal nebula. It developes branches and assumes a spiral figure. Stars have already been formed by the time a galaxy reaches this stage. By this time also most of its gas and dust contents are used up to produce millions of stars.

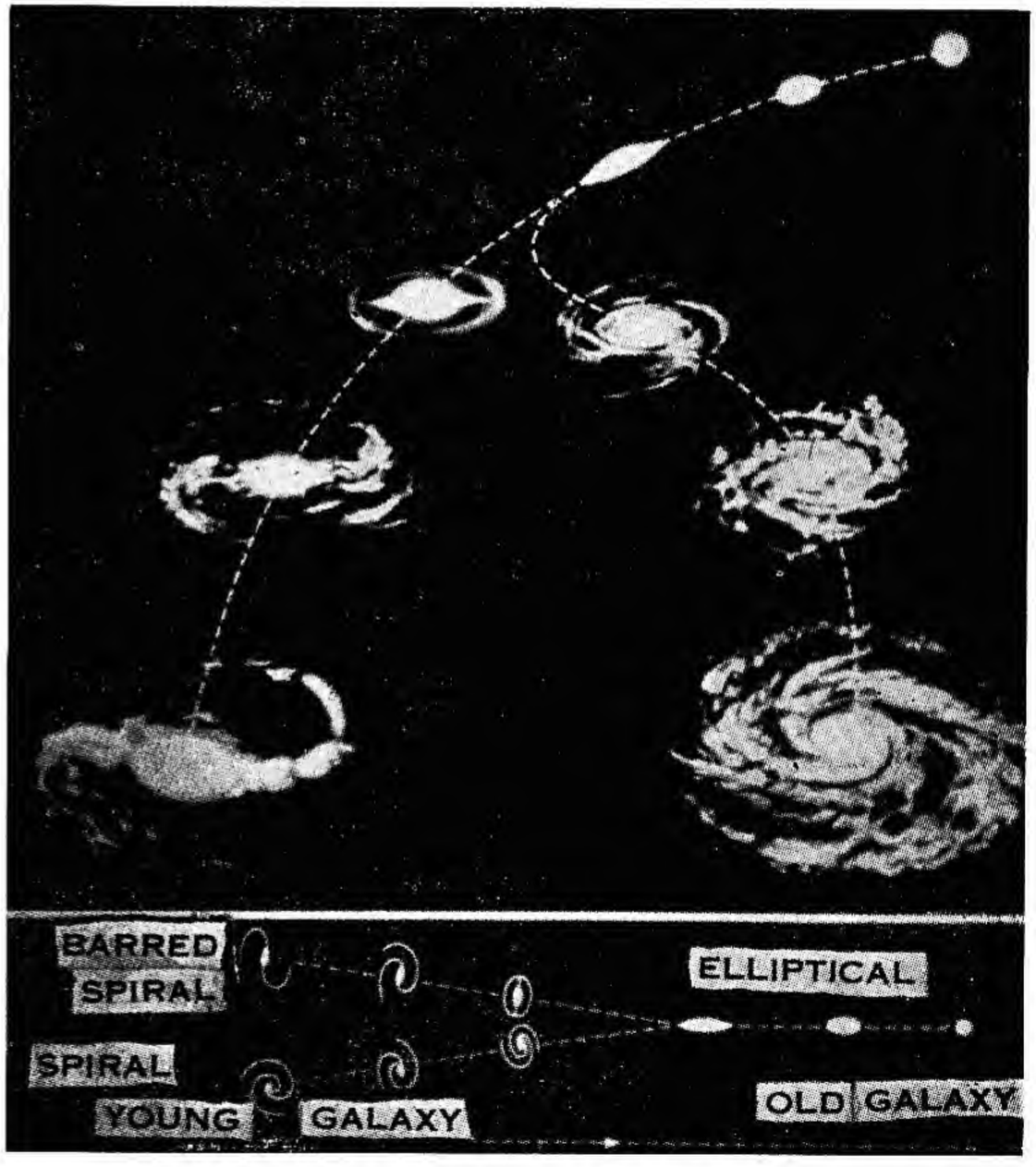

Fig. 8.5 Evolution of Galaxies.

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Observer's Latitude : 25° N

AUGUST
ZENITH
NIGHT - SKY

April	1	at	5 a. m. (I. S. T.)
May	1	at	3 a. m.
July	1	at	11 p. m.
August	**1**	**at**	**9 p. m.**
September	1	at	7 p. m.

April	15	at	4 a. m. (I. S. T.)
May	15	at	2 a. m.
July	15	at	10 p. m.
August	**15**	**at**	**8 p. m.**
September	15	at	6 p. m.

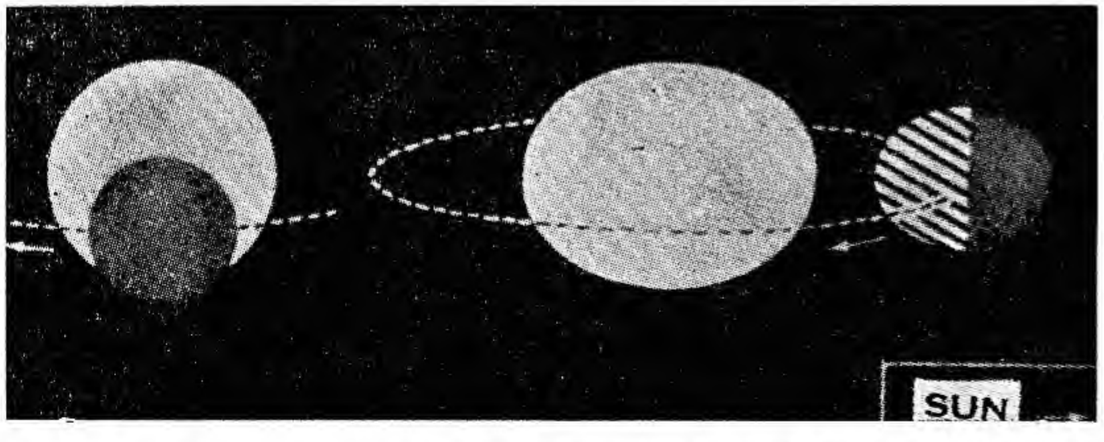
Variable Stars

THE STARS twinkle, but that would not lead us to conclude that they change their brightness continuously. There are, however, some stars which are known to vary actually in their brightness. Such star are called Variable Stars. Algol of Perseus (β) and Mira of Cetu (o) are famous examples if variable stars. Their variable nature has been known from ancient times, but more accurate observations, made in modern times, determine the nature of their variability.

The variable character of a star is examined by systematically observing its luminosity at regular intervals, visually and photographically. The values observed are then compared with other non-variable stars.

More than 10,000 variable stars are known now. With naked eye we see not more than about 4750 stars, but only 3% of them are found to be variable stars.

There are two kinds of variables. When the variation in light is caused by two or more components of stars, revolving round each other, temporarily blocking out one. β in Perseus (Algol) is a typical example of this class. These variable stars are called Eclipsing Variables. In some stars the variation in light is due to periodic expansion or contraction of the star, star δ in Cepheus is a typical representative of this class, and, therefore, Such stars are called Cepheid Variables* The change in size of the Star is supposed to be due to nuclear reactions. going on in its interior. The length of the period in such Variables classifies them further into long period, short period or irregular variables.



Fig, 8.5 : Diagrammatic view of an Eclipsing Variable Eclipsing Variable

There are some stars which are called Explosive Stars. They become very bright in a short time and then rapidly fade away. It is suggested that as a result of the nuclear reactions in the interior ot the star, a part of its atmosphere is blown off by the explosion. This accounts for the expansion and shrinkage. Stars in this very explosive condition are called Novae or Super Novae according to their behaviour. The brightnes:, during the explosive stage, can increase sometimes by as much as 10 magnitudes, equivalent to a 10,000 times greater luminosity. If a Super Novae were to explode in the position of the Sun, the Earth would be completely evaporated. A Super Novae at the distance of Sirius from us would give us more light than the Full Moon.

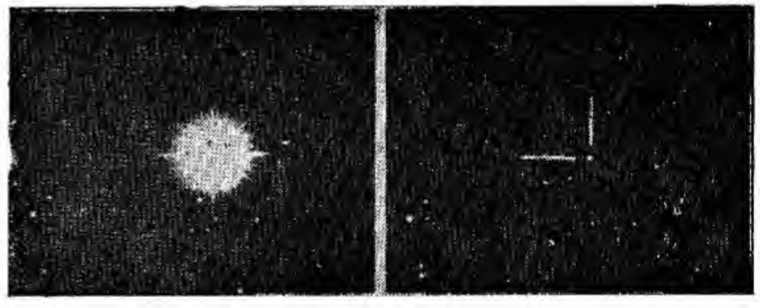


Fig. 8.6 : Varying Magnitudes of the same star in Hercules
Left : maximum brightness on 10 March 1935 Right : minimum brightness on 6 May 1935

By making a close study of several thousand Variable Stars it has been possible to establish a relationship between luminosity and period of variation. Making use of this relationship it is further possible to estimate the absolute magnitude of a star and then its distance from us.

The variable star η in Carina is known to have varied a great deal.

This star grew in brightness from 1814 to 1843 and it became invisible in 1866.

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* See *Nuclear Reactions* at page 243.

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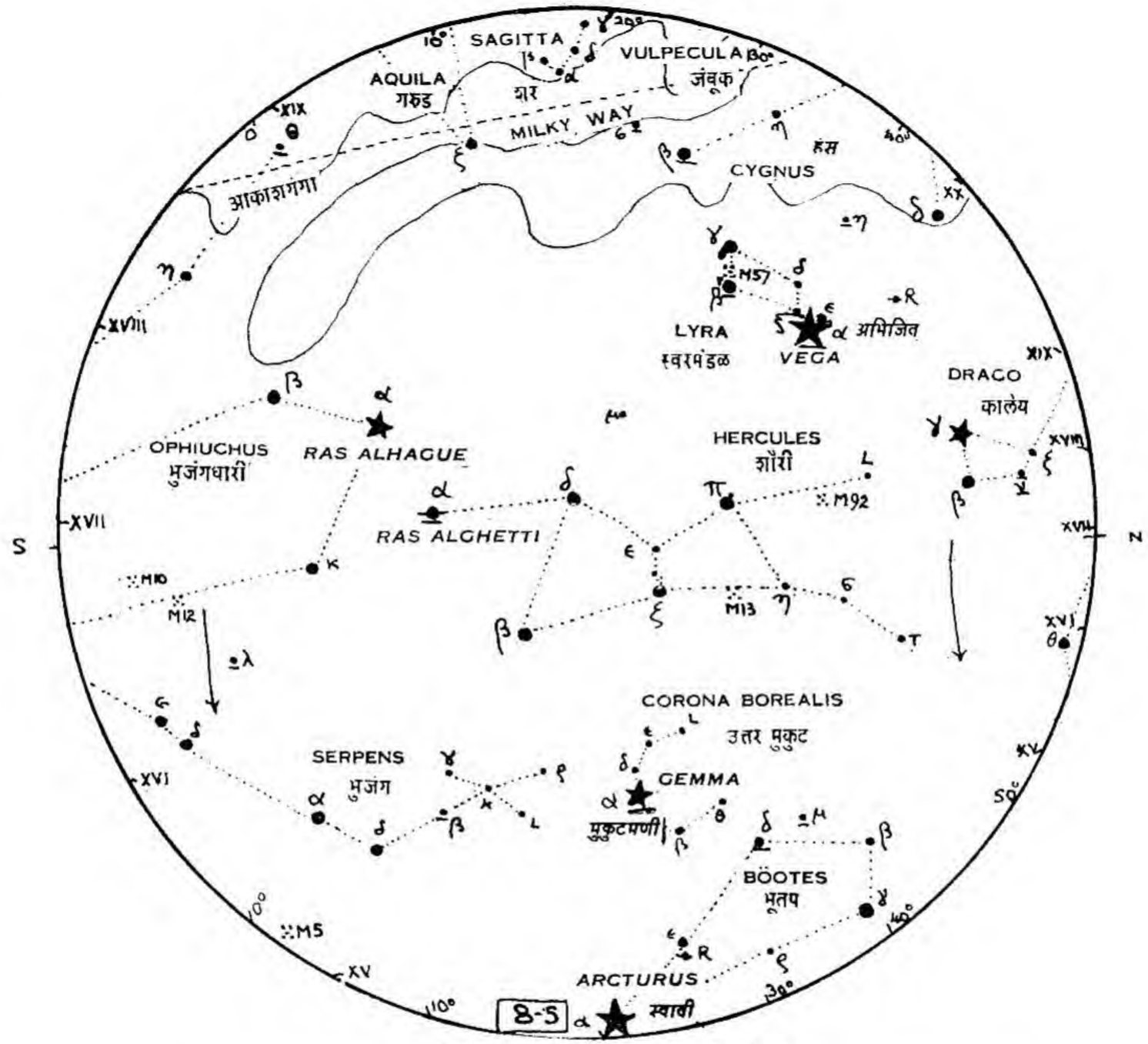

Observer's Latitude : 25° N

AUGUST ZENITH KEY - MAP

April	1	at	5	a. m. (I. S. T.)
May	1	at	3	a. m.
July	1	at	11	p. m.
August	**1**	**at**	**9**	**p. m.**
September	1	at	7	p. m.

April	15	at	4	a. m. (I. S. T.)
May	15	at	2	a. m.
July	15	at	10	p. m.
August	**15**	**at**	**8**	**p. m.**
September	15	at	6	p. m.

Scutum

THIS CONSTELLATION is situated to the north of Sagittarius and to the west of Aquila. The nomenclature is comparitively modern. Polish warrior Sopieski saved Europe from the Turks in 1683 A. D. and this event was commemorated by naming the constellation as Sobieski's Shield. The word Scutum means a Shield.

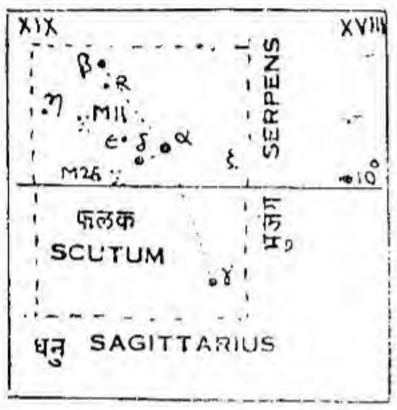

Fig. 8.7 : Scutum

There is a grand fan-shaped star cluster, known as M 11, and it lies beyond the line joining β and ε, and it has a bright star at its apex.

There are dark structures to the south of the constellation. (See fig. 8.7 Scutum.)

* * *

Corona Australis

THIS IS a southern constellation and the Westerners have given it this name, because it very much resembles the already known Corona Borealis (Northern Crown). It lies to the south of Sagittarius and to the east of the tail of the scorpion (Scorpius).

This constellation contains 2 open star clusters. The star γ is a binary with a period of about 120 years.

According to some, this constellation represents the Crown of the Centaur (Centaurus), which is seen only from the southern hemisphere.

The Arabs and the Chinese had figured this constellation as a tortoise. (See fig. 8.8 for Corona Australis)

* * *

Telescopium

THIS NOMENCLATURE is modern. The constellation lies on the southern side of Sagittarius and Corona Australis.

There are two fourth magnitude stars and near its western boundary there is an open cluster. (See fig. 8.8 for Telescopium)

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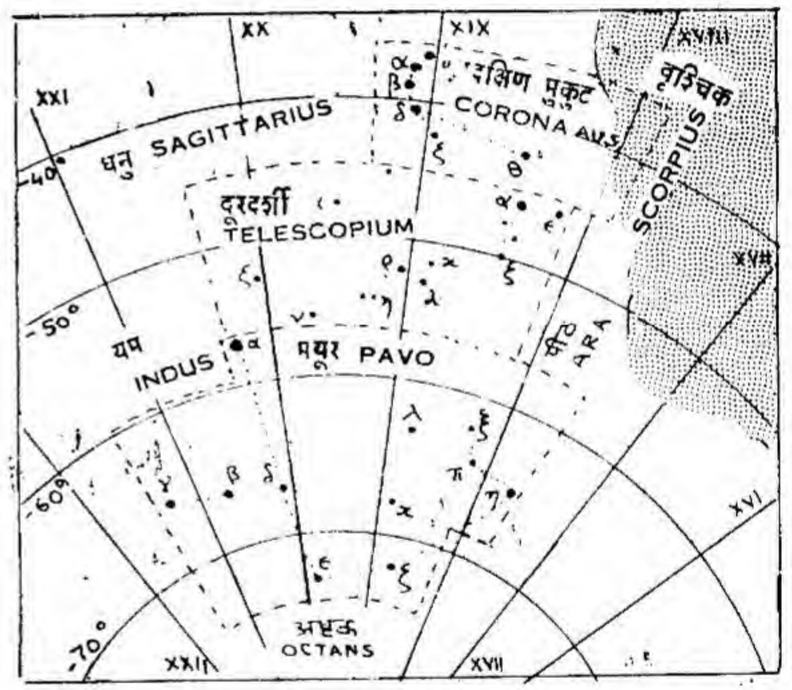

Fig. 8.8 : Corona Australis, Telescopium, Pavo.

Pavo

THIS CONSTELATION, meaning the Peacock, is situated to the south of the constellation Telescopium. Its prominent star α is double and of magnitude 2.1. The star K is a variable, varying from 4.2 to 5.1 magnitudes and its period is 9 days. ζ is a double star with a clear colour contrast. (See fig. 8.8 for Pavo).

* * *

Observer's Latitude : 25° N

SEPTEMBER
NORTH
NIGHT-SKY

May	1	at	5	a. m. (I. S. T.)
June	1	at	3	a. m.
August	1	at	11	p. m.
September	**1**	**at**	**9**	**p. m.**
October	1	at	7	p. m.

May	15	at	4	a. m. (I. S. T.)
June	15	at	2	a. m.
August	15	at	10	p. m.
September	**15**	**at**	**8**	**p. m.**
October	15	at	6	p. m.

Cygnus

LOOKING TOWARDS the nothern sky at about 8 p. m. in the middle of September, the Milky Way appears on the left. We can see in it, from the horizon upwards, Cassiopeia. Further, there are two bright stars, almost on a horizontal line; the one on the right in the Milky way is Deneb in Cygnus and the one on the left, on the lower edge of the Milky Way, is Vega in Lyra.

Cygnus means the Swan and the name of the constellation is of western origin. This constellation is known as *Hansa*, (हंस) meaning the swan, in Indian astronomy. But the nomenclature is modern. It is, however, very significant because of the numerous allusions to swans, in the form of stars, swimming gaily in the heavenly Ganges namely the Milky Way.

According to Greek Mythology, a musician by name Orpheus was transformed into a swan and placed among the stars so that he could be near his well-loved harp.

Cygnus is often described as the Northern Cross, on the analogy of the Southern Cross (Crux),* because the lines joining α and β and ε and δ do make up the figure of a cross.

The principal star α is called Deneb or Arided and the star β at the other end of the line is called Albireo. In the diagrammatic representation β occupies the head and the tail of the Swan. The other stars are ε (Gicnah) and π (Azal Phalage).

β, μ and o_2 are double stars and can be seen through a powerful binocular. o_2 is actually a triplet. Beyond the tail of the swan there is a beautiful star-cluster known as M 39 which can also be seen with a binocular.

Star K, on the line joining β and γ, is a variable of Mira type. Its brightness changes by 10 magnitudes and its period is 413 days.

In the vicinity of star 61, of Cygnus, there is an extraordinary black spot specially visible on account of the glow of light from the densely packed stars of the Milky Way. This spot is described, popularly, as " a sack of coals ". The dark spot is now regarded as nebulous matter which cuts out the light from stellar regions between them. The star 61 Cygni happens to be one of our nearest neighbour, being about 10 light-years away.

With the advent of Radio-telescopes,** it has now been discovered that there is a very strong source of radio emission in the direction of Cygnus. The amount of energy radiated from this source must be very large, indeed, in as much as the small fraction reaching the Earth, from such an enormous distance, is comparable to the energy reaching us from the Sun which is only 8.3 light-minutes away. The radiation energy from the source in Cygnus is equal to 18 times that from the Sun.

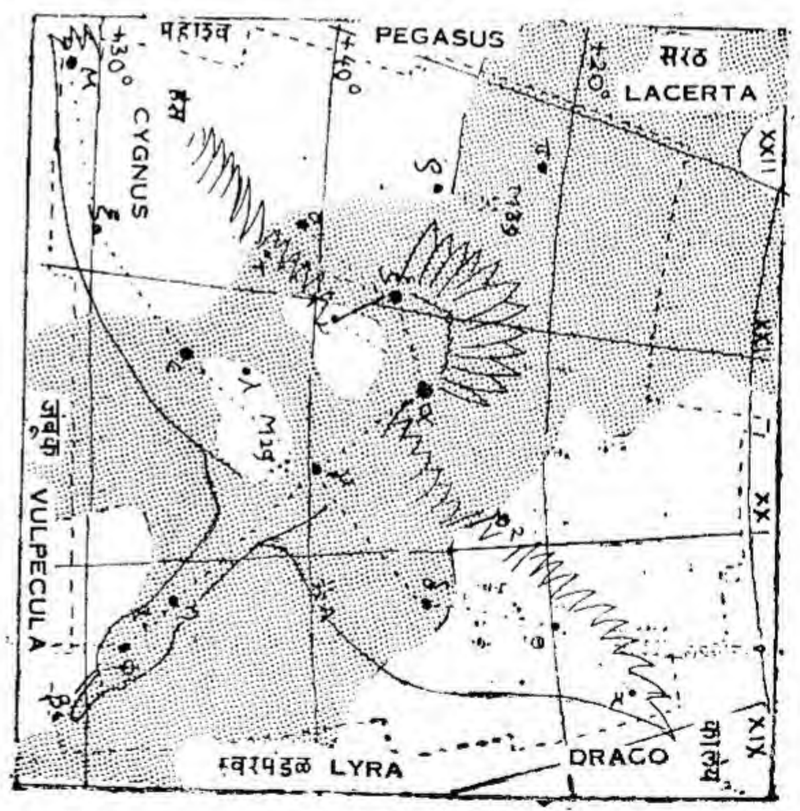

Fig. 9.1 : Cygnus

* See *Crux* at page 103

** See *Radio-Tetescope* at page 211

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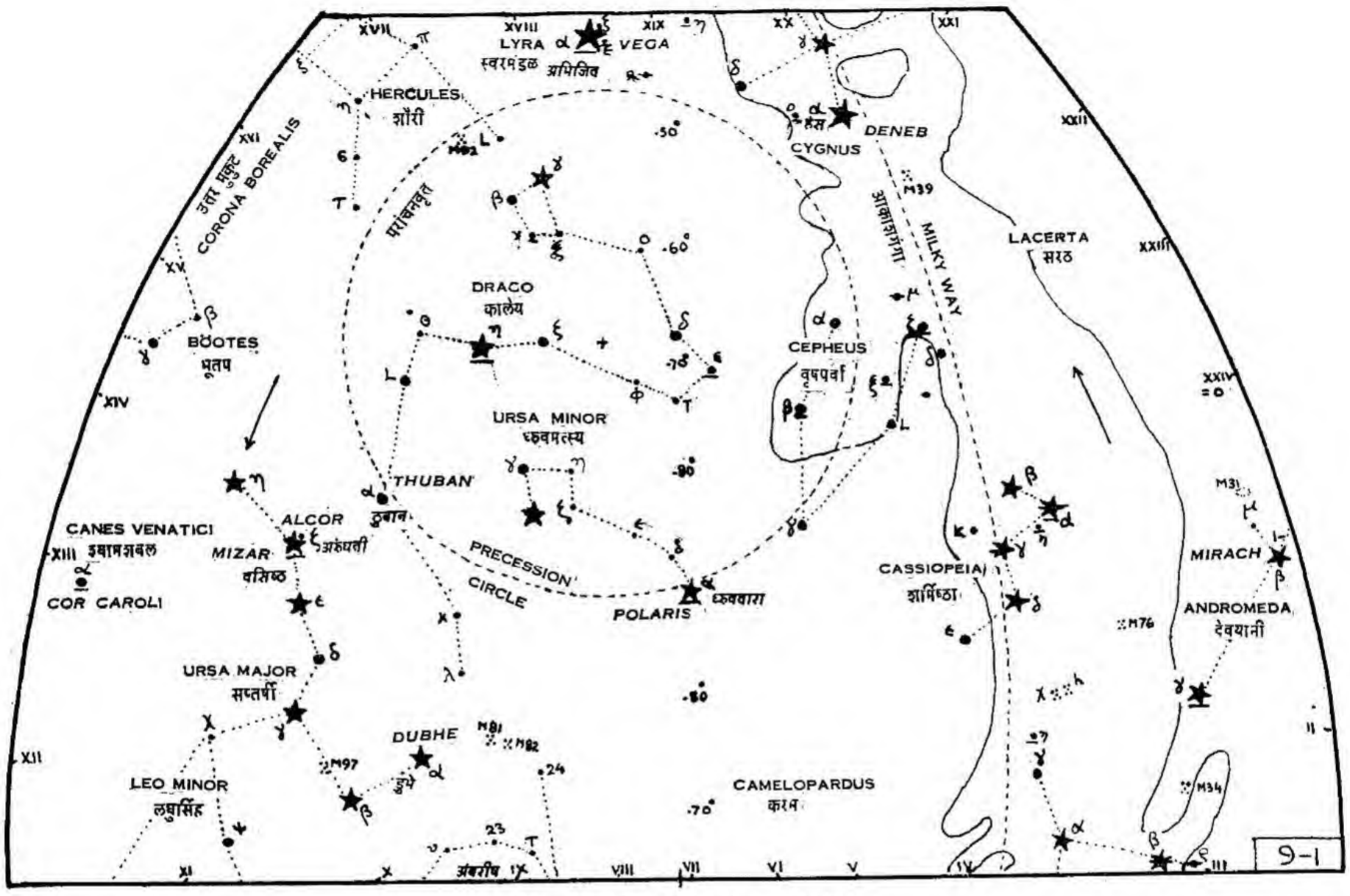


Observer's Latitude : 25°N

SEPTEMBER
NORTH
KEY-MAP

May	1	at	5 a. m. (I S. T.)
June	1	at	3 a. m.
Augustl	1	at	11 p. m.
September	**1**	**at**	**9 p. m.**
October	1	at	7 p. m.

May	15	at	4 a. m. (I. S. T.)
June	15	at	2 a. m.
August	15	at	10 p. m.
September	**15**	**at**	**8 p. m.**
October	15	at	6 p. m.

SEPTEMBER : NORTHERN SKY

Prominent Stars :

Five bright stars in Cassiopeia forming the letter W or M.

α in Cygnus (Deneb).

α in Draco (Thuban); Pole Star about 2700 B. C.

α in Lyra (Vega); Pole Star of the future.

α, β in Ursa Major (The Pointers).

α in Ursa Minor (Polaris); present Pole Star.

Double Stars :

γ in Andromeda, gold and blue, seen with a small telescope.

η in Cassiopeia, seen with a 5 cm telescope.

β, ξ in Cepheus, seem with a 5 cm. telescope.

ν in Draco, 2 equally bright stars of magnitude 5, seen with a binocular.

ε, η in Draco, only for a 7.5 or 10 cm. telescope.

α in Lyra, optical pair 56″ apart, magnitudes 0.2 and 10.5.

ζ in Ursa Major (Mizar) with Companion (Alcor).

α in Ursa Minor, wide double 18″ apart seen with a 5 cm. telescope.

Supernova :

Appeared in Cassiopeia in 1572A. D. It was as bright as Venus, but disappeared in 1574 A. D.

Variable Stars :

β in Lyra, representative type, period 12.91 days.

χ in Cygnus, Mira type, with variation through 10 magnitudes, period 413 days.

δ in Cepheus, a representative type, period 5.37 days.

Nebulae and Star Clusters :

M 31 (NGC 224) in Andromeda, extra-galactic and receding from us; seen with naked eyes.

NGC 752 in Andromeda near γ, large and open cluster.

M 39 (NGC 7092) in Cygnus beyond α and near π^2, open cluster, seen with a field glass.

In Cygnus, here is a strong source of radio-emission.

M 15 (NGC 7078) in Pegasus, near ε. Globular and brilliant.

χ and h in Perseus beyond γ, beautiful clusters.

* * *

Chronograph

THIS IS an instrument for recording exact time at which an event occurs. One type of Chronograph uses pens on a moving strip of paper. A clock operates one pen at seconds intervals. As soon as an observer sees an event (such as an occultation of a star by the Moon) he presses a button which operates the second pen. By comparison of the pen-traces on the paper, the time of the event is obtained. More accurate and specialised Chronographs photograph Cathode Ray Oscilloscope, the time and the event-marks appearing as spot movements.

* * *

Observer's Latitude : 25°N

SEPTEMBER
EAST
NIGHT-SKY

May	1	at	5	a. m. (I. S. T.)
June	1	at	3	a. m.
August	1	at	11	p. m.
September	**1**	**at**	**9**	**p. m.**
October	1	at	7	p. m.

May	15	at	4	a. m. (I. S. T.)
June	15	at	2	a. m.
August	15	at	10	p. m.
September	**15**	**at**	**8**	**p. m.**
October	15	at	6	p. m.

Capricornus

CAPRICORNUS IS not a very conspicuous constellation and it lies in the southern half of the Ecliptic, through which the Sun appears to travel among the stars. The line drawn through Vega (α of Lyra) and Altair (α of Aquila) meets the Ecliptic near the star α of Capricornus.

Capricornus is a western name. It means the Goat. The part of the sky where this constellation is situated is particularly interesting. There are here, in addition to the goat, two heavenly fishes, and a dolphin. The Fishes are, the Northern Fish, known as Pisces, and the Southern Fish, known as Pisces Austrinus. There is also a Whale known as Cetus and there is a Dolphin known as Delphinus. Thus quite a number of sea animals are represented in this part of the sky.

According to one mythological legend, Capricornus, the Goat, was placed among the constellations to commemorate the adventure of the God Pan with the terrible monster Typhon. Everybody had run away in panic before Typhon. But when Pan along with others jumped into a river, his companions and himself were transformed into two Fish and a Sea-goat, This sea-goat is Capricornus.

There is another version of this legend. While Greek nymphs and Goddesses were bathing in a river, the God Pan wanted to make fun of them. He changed himself into a goat and jumped into the river. When he did this, the part of his body that was immersed in water took the shape of a fish, while upper half, which was not immersed, remained that of a goat as before. This would account for the peculiar drawing of this constellation, half goat and half-fish.

One more legend suggests that the God Jupiter was fed on goat's milk and that accounts for his unusual strength. Out of gratitude, this particular goat Almetia was given a place among the constellation in the from of 28 stars.

Indian name of Carpicornus is *Makar* (मकर) and it occurs in the name of the festival *Makar Saṅkramaṇa* (मकर संक्रमण). Some 1400 years ago Sun used to be in this constellation when passing through the southern-most part of the Ecliptic known as Winter Solstice.* This is the time when we have the shortest day. At presenr, the Sun enters *Makar* or *Capricornus*, in the 3rd. week of the January, insted of on the 22nd of Dccember. This shift can be explained by the Precession of Equinoxes,** resulting in the movement of the solstice at the rate of 1 day in 72 years.

The western bright star α of Capricornus is a double and can be seen as such with naked eyes. One of the components is itself a double and the other is a triple The Arabs used to call the star Giedi. The star γ is called Zuben al Hakarabi

The star β at the other end of the constellation is also a double and, remarkably enough, their components are also doubles. The Arabic name of this star is Dabih.

There is a globular cluster M 30 near ζ and it is a beautiful sigh[t] with a field glass. Its distance from us is equal to 47.000 light years.

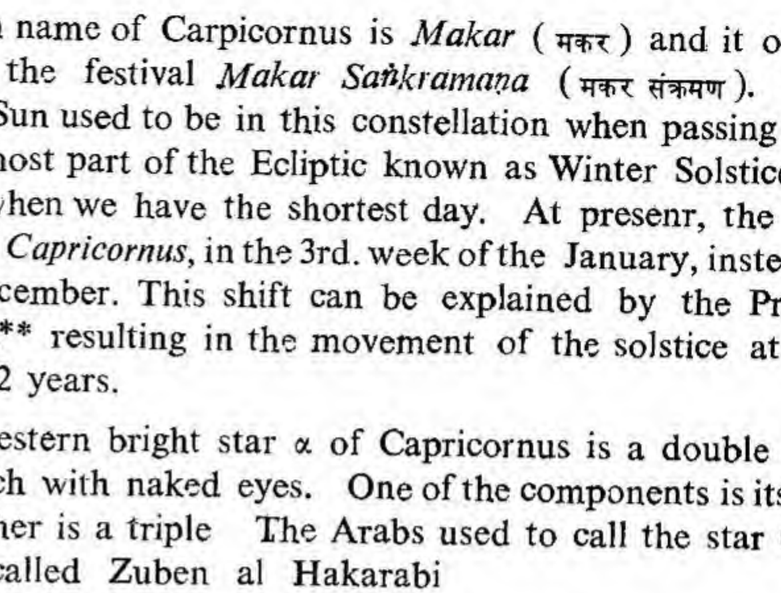
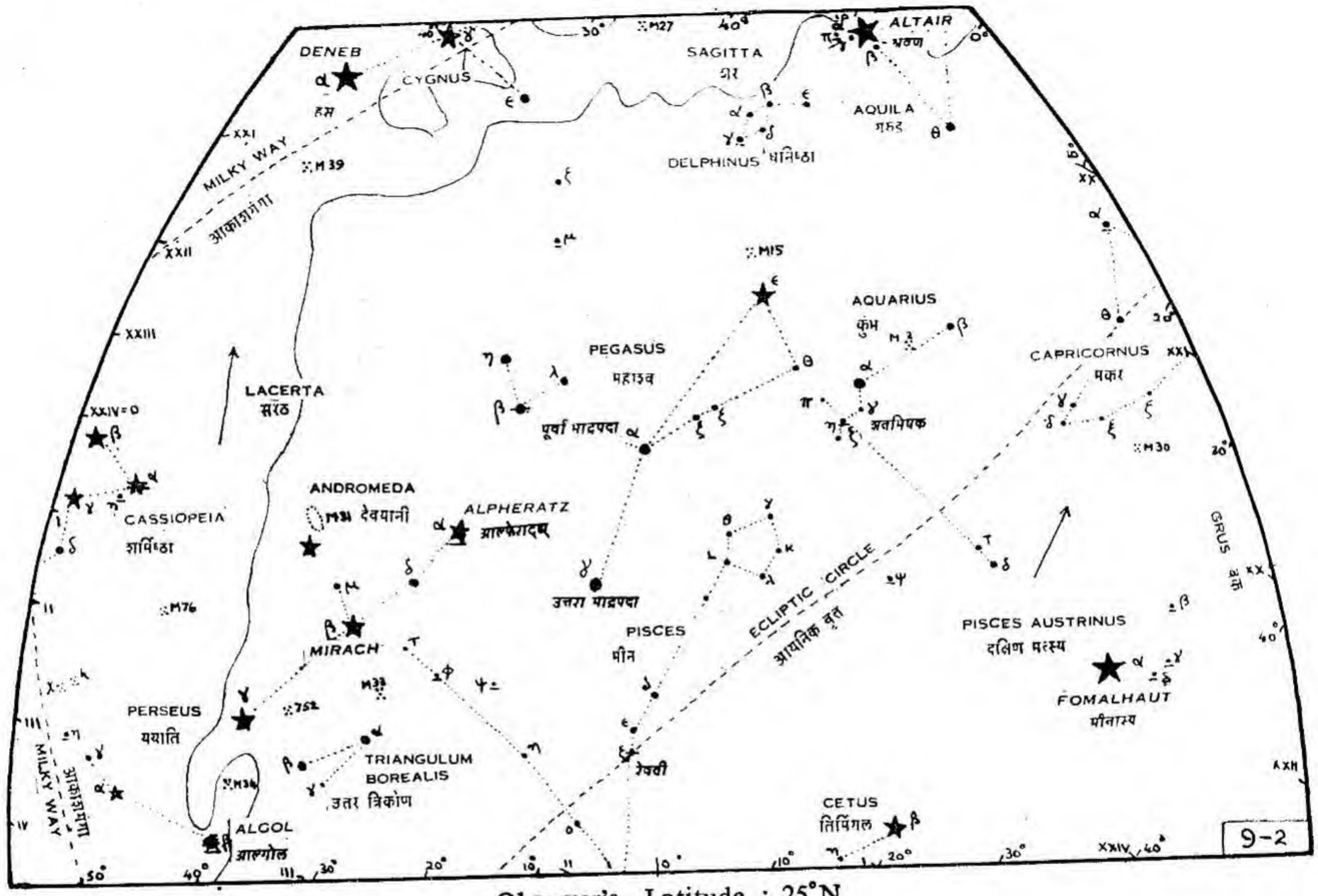


Fig. 9.2 : Capricornus

* * *

* See *Solstice* at page 3.

** See *Precession* at page 51.



Observer's Latitude : 25°N

SEPTEMBER
EAST
KEY-MAP

May	1	at 5 a.m. (I.S.T.)	May	15	at 4 a.m. (I.S.T.)
June	1	at 3 a.m.	June	15	at 2 a.m.
August	1	at 11 p.m.	August	15	at 10 p.m.
September	**1**	**at 9 p.m.**	**September**	**15**	**at 8 p.m.**
October	1	at 7 p.m.	October	15	at 6 p.m.

SEPTEMBER : **SOUTHERN SKY**

Prominent Stars :

α in Andromeda (Alpheratz).

α in Aquarius (Sad-al-melik).

α in Aquila (Altair).

α in Cygnus (Deneb).

Five Stars in Cassiopeia, forming the letter W or M.

α, β in Pegasus (Markab and Sheat).

β in Pisces Austrinus (Fomalhaut).

α in Perseus (Algol).

Double Stars :

γ in Andromeda, gold and blue, seen through a small telescope.

ψ_1 in Aquarius, nice double, to be seen with a field-glass.

ξ in Aquarius, seen with a 10 cm. telescope.

π in Aquila, object for a 7.5 cm. telescope.

ψ_1 ζ in Pisces, easily resolvable doubles.

α, φ in Pisces, seen only through a large telescope.

β in Pisces Austrinus, 30″ apart, magnitudes 4.4 and 7.8.

Variable Stars :

η in Aquila, Cepheid type, period 7.18 days.

χ in Cygnus, Mira type, brightness changes through 10 magnitudes.

β in Pegasus, variation from 2.2 to 2.7 magnitudes.

Nebulae and Clusters :

M 31 (NGC 224) in Andromeda, near ν, extra galactic and receding from us, seen with naked eyes.

Distance = 500,000 parsec = 1,600,000 light-years.

NGC 752 in Andromeda near γ, large and open.

M 2 (NGC 7089) in Aquarius near β, seen with naked eyes.

M 30 (NGC 7099) in Capricornus near ζ, globular, seen with a field-glass.

M 39 (NGC 7092) in Cygnus beyond α, near π^2, open cluster seen with a field-glass.

In Cygnus, there is a very strong source of radio emission.

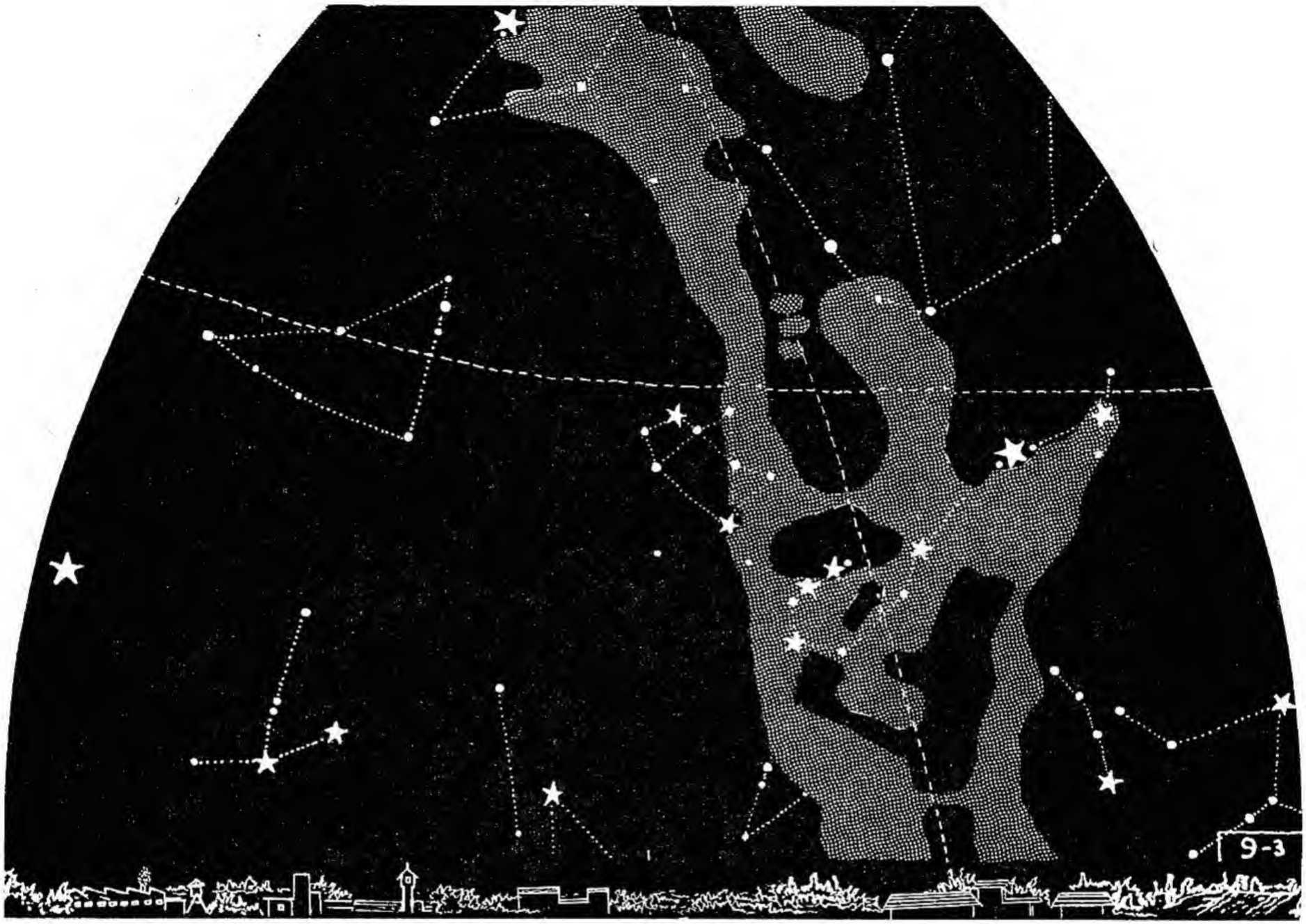
M 15 (NGC 7078) in Pegasus near ε, globular and brilliant.

* * *

Durchmusterung

THIS IS a special type of star catalogue in which the properties of all stars down to a certain magnitude, in a particular part of the sky or the whole sky, are described. The Bonner Durchmusterung (B D) lists the positions of 450,000 objects down to a magnitude of 9.5 The Harward Durchmusterung and Potsdamer Durchmusterung list stars of photographic magnitudes down to 6.5 and 7.5 respectively A well-known spectral Durchmusterung is the Henry Draper Catalogue.

* * *



Observer's Latitude : 25°N

SEPTEMBER SOUTH NIGHT-SKY

May	1 at 5 a. m. (I. S. T.)	May	15 at 4 a. m. (I. S. T.)
June	1 at 3 a. m.	June	15 at 2 a. m.
August	1 at 11 p. m.	August	15 at 10 p. m.
September	**1 at 9 p. m.**	**September**	**15 at 8 p. m.**
October	1 at 7 p. m.	October	15 at 6 p. m.

Equulus

THE NAME of the constellation means the Little Horse. It lies to the east of Aquila and Delphinus. It contains a fairly bright star α of magnitude 4.6 called Kitalpha. Star δ is a close binary, with components each of magnitude 5. There is another companion to this star of magnitude 10, making it a triplet. (For Equulus See fig. 7.5 on page 147).

* * *

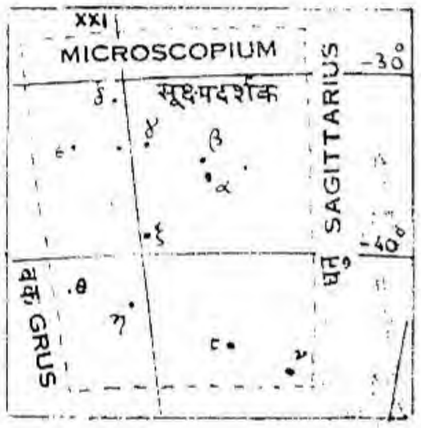


Fig. 9.3 : Microscopium

Microscopium

THIS IS an inconspicuous constellation in the Southern Sky with a modern nomenclature meaning the Microscope. It lies between Capricornus, Pisces Austrinus, Grus, Indus and Sagittarius. It contains no star brighter than magnitude 5.

* * *

Indus

THE NAME of the constellation means the Indian. It lies in the southern hemisphere. There are only two orange-coloured stars of magnitudes 3 and 4 ant they are situated to the east of the brighd star α of the constellation Pavo.

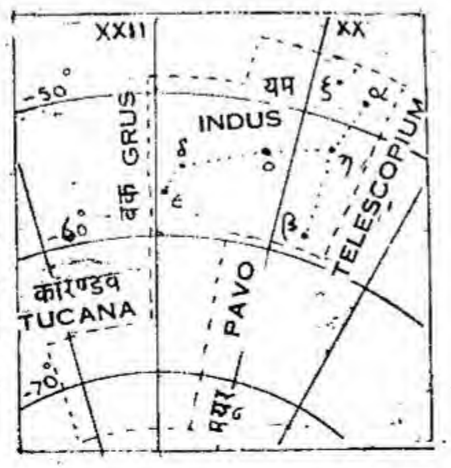


Fig. 9.4 : Indus

* * *

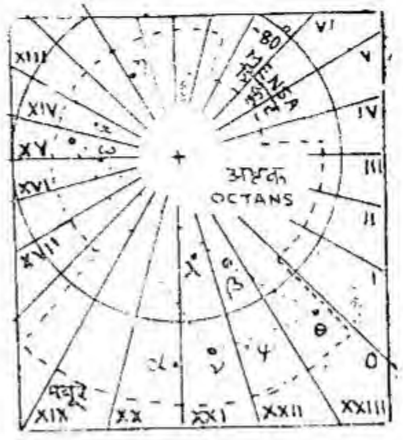


Fig. 9.5 : Octans

Octans

THIS CONSTELLATION lies beyond 75° South and therefore remains almost invisible to us. The South Celestial Pole is situated in it. The star near to the South Celestial Pole is σ in Octans. Its magnitude is 5.5., and it is only 50′ away from the actual Celestial South Pole. Star 5 is directly to the south of the constellation Apus.

* * *

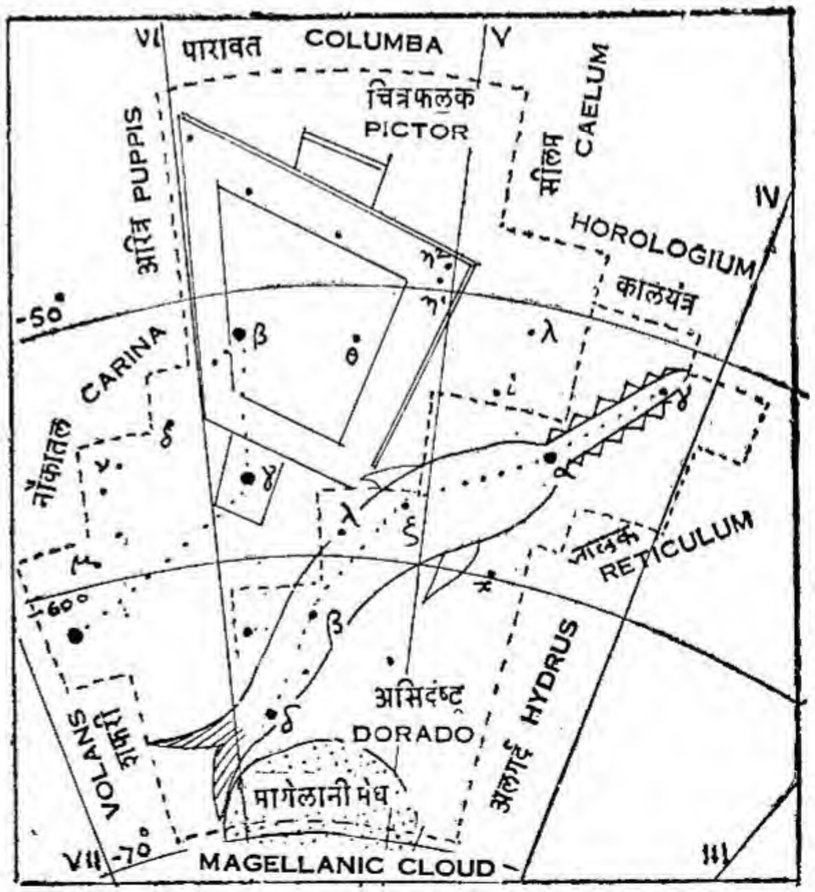
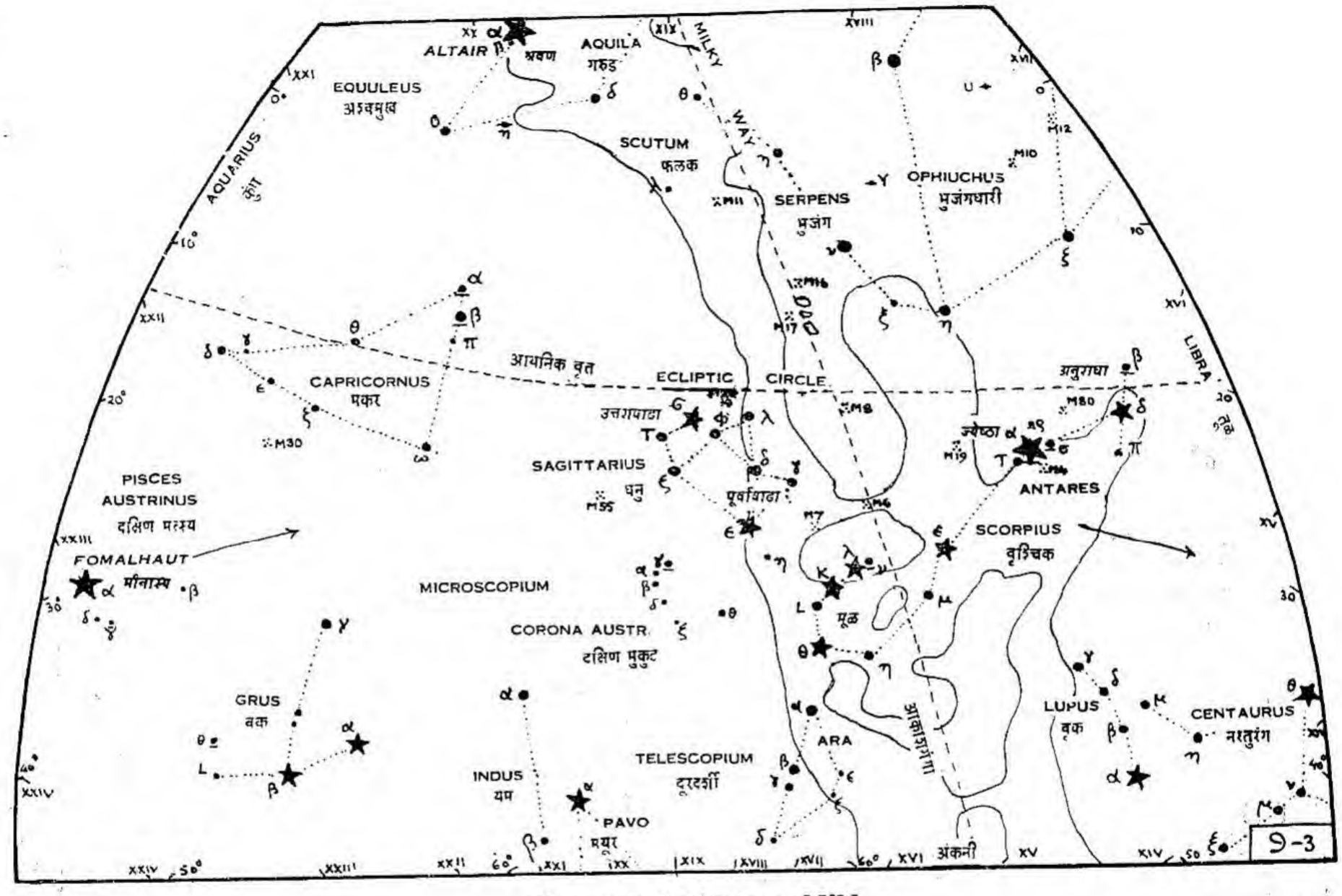


Fig. 9.6 : Dorado

Dorado

THE NAME is modern and it means a Sword Fish. The most important object in this constellation is a large and bright nebula. It is known as the Large Magellanic Cloud, which is a Galaxy situated close to our Galaxy, the Milky Way. This Galaxy is clearly visible to the naked eyes. (For Magellanic Cloud see page 113).

* * *



Observer's Latitude : 25°N

SEPTEMBER SOUTH

KEY-MAP

May	1 at 5 a. m. (I. S. T.)	May	15 at 4 a. m. (I. S. T.)
June	1 at 3 a. m.	June	15 at 2 a. m.
August	1 at 11 p. m.	August	15 at 10 p. m.
September	**1 at 9 p. m.**	**September**	**15 at 3 p. m.**
October	1 at 7 p. m.	October	15 at 6 p. m.

Prominent Stars :

α in Aquila (Altair).

α in Capricornus (Giedi).

α in Grus.

α in Pavo.

α in Pisces Austrinus (Fomalhaut).

α in Scorpius (Antares).

Double Stars :

π in Aquila, seen with a 7.5 cm. telescope.

θ in Grus, magnitudes 4.5 and 7.0.

Star 70 in Ophiuchus, between η Serp. and β Oph, seen with a 5 cm. telescope.

β in Pisces Austrinus, 30″ apart, magnitudes 4.4 and 7.8.

α in Scorpius, faint component only 3″ away, red and green.

β, ν, σ in Scorpius, wide doubles.

ξ in Scorpius, seen with a 5 cm telescope.

ν in Scorpius. Main as well as the companions have, each of them, another companion.

Variable Stars :

η in Aquila, of the Cepheid type, with period of 7.18 days.

Nebulae and Star Clusters :

M 30 (NGC 7099) in Capricornus near ζ, globular, seen with field-glass.

M 10 (NGC 6254), M 12 (NGC 6218), M 19 (NGC 6273) in Ophiuchus, all very faint.

M 17 (NGC 6618) in Sagittarius, large and bright, known as ' Omega ' or ' Horse-shoe ' nebula.

M 8 (NGC 6523) in Sagittarius, galactic gaseous nebula, seen with naked eyes.

M 22 (NGC 6656) in Sagittarius between μ and σ, globular, diam 17′

M 11 (NGC 6705) in Scutum, beyond the line joining β and ε, grand fan-shaped cluster.

NGC 6633 in Serpens near θ, seen with a field-glass.

M 4 (NGC 6121) in Scorpius near α, bright and globular.

M 6 (NGC 6405) in Scorpius, above the tail-end, galactic cluster.

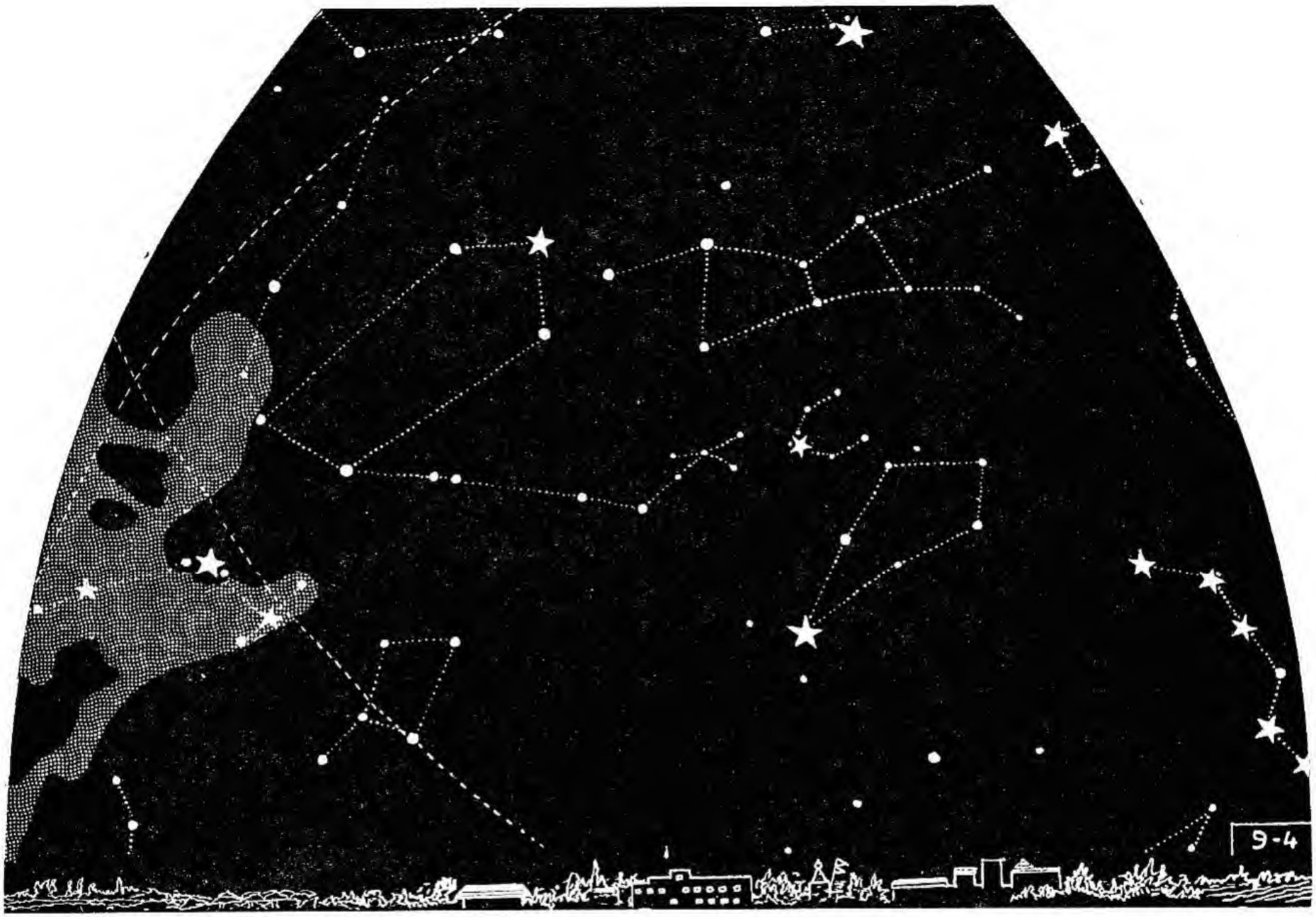
M 7 (NGC 6475) in Scorpius, brilliant open cluster, seen with naked eyes.

* * *

Ephemeris

THIS IS an astronomical table giving the computed positions of a celestial body for a series of future dates. From the orbital position of the body and the Earth, the distance between the two and their situation in relation to one another are calculated. The Right Ascension and the Declination of the object, for example, are then known. These positions are computed annually and those of the Sun, Moon and planets, and certain other bodies are published in various almanacs.

* * *



Observer's Latitude : 25° N

SEPTEMBER
WEST
NIGHT-SKY

May	1 at 5 a. m. (I. S. T.)	May	15 at 4 a.m. (I. S. T.)
June	1 at 3 a. m.	June	15 at 2 a. m.
August	1 at 11 p. m.	August	15 at 10 p. m.
September	**1 at 9 p. m.**	**September**	**15 at 8 p. m.**
October	1 at 7 p. m.	October	15 at 6 p. m.

Libra

LOOKING AT the night sky in the west, during the month of September, two very bright stars can be seen well above the horizon. The star, almost due west is Arcturus (α of Boötes) and the star on the left-hand side is Antares (α of Scorpius). Below Antares and exactly on the Ecliptic Circle lies the constellation known as Libra.

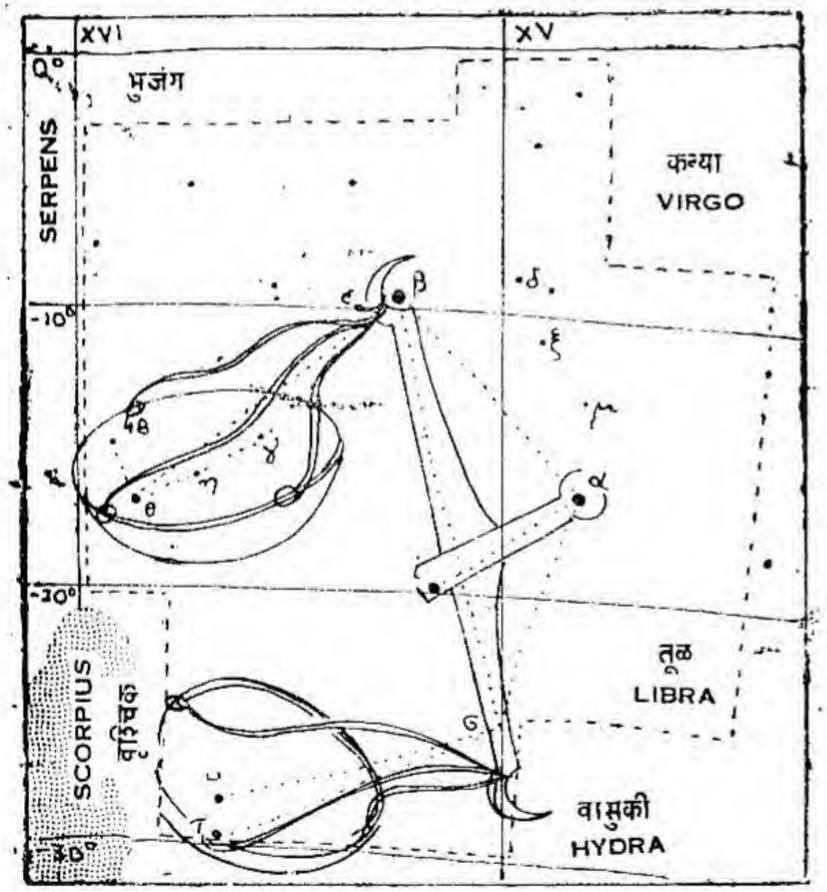


Fig. 9.7 : Libra (Tulā)

Twice during the year, day and night are of equal length. The pring equinox falls on the 21st of March and the autumnal equinox falls on the 22nd of September. The ecliptic circle, namely the Sun's apparent path in the sky, meets the celestial equator in these two points known as the Equinoxes. Since the time when the autumnal equinox coincided with the entry of the Sun in the constellation Libra, the name has a significance. Libra means a balance and the constellation used to be figured as a beam balance with scale pans. The position is not so obvious now, because the autumnal equinox has shifted to Virgo. The scales indicated the equality of day and night.

The two brightest stars are α and β (Zuben el Zenubi) is of magnitude 2.9. The next bright star is β (Zuben el Chameli) of magnitude 2.7 and it appears green. The star γ is called Zuben el Hakarabi.

According to Indian reckoning this Zodiacal division *Tulā* (तुला) includes one half of *Citrā* (चित्रा) and three-fourths of *Viśākhā* (विशाखा). and *Swāti* (स्वाती)· The star Citra is Spica (α of Virgo) and Swātī is Arcturus (α or Boötes). The stars α and β in Libra ar regarded as Viśākhā (विशाखा).

* * *

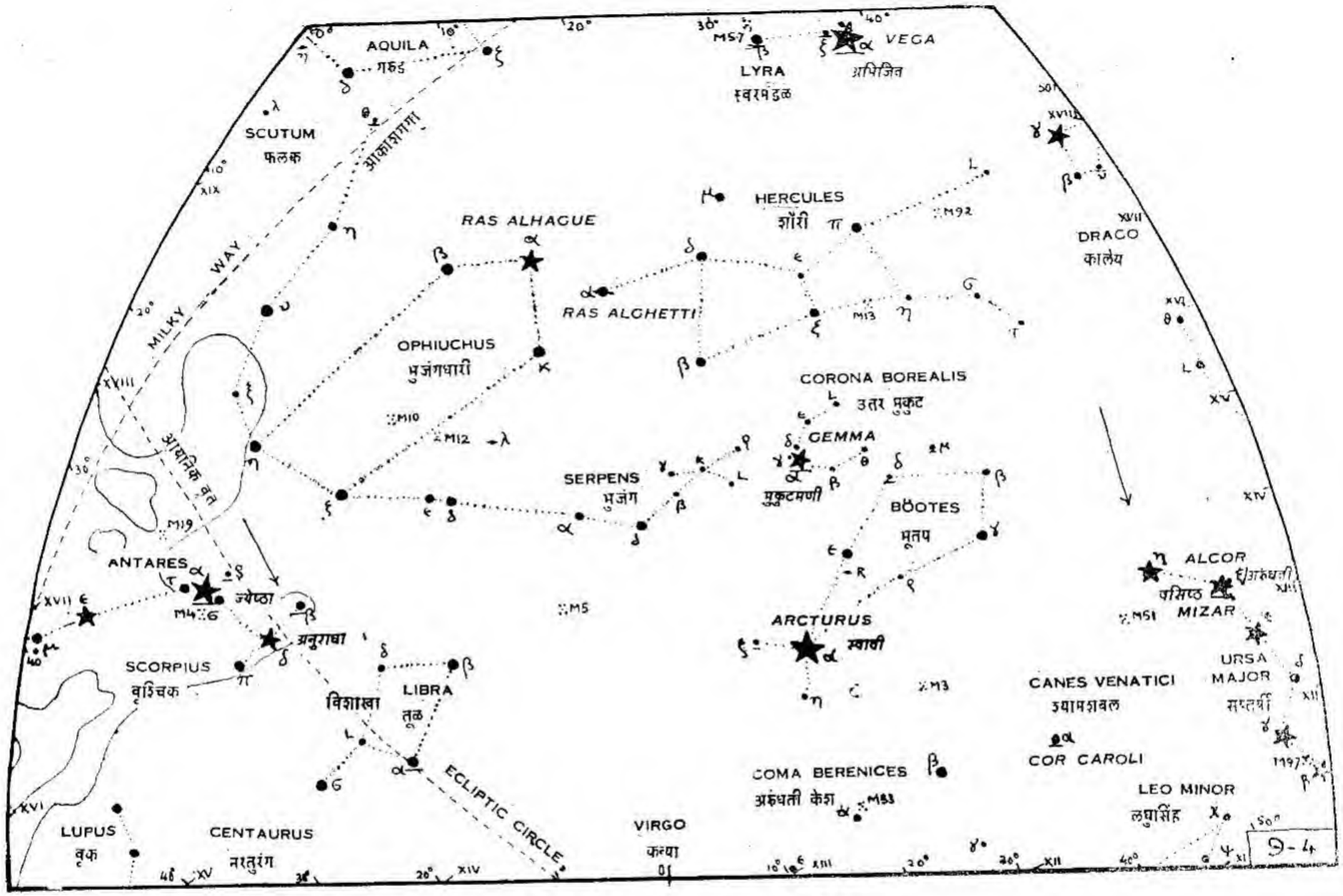
Ephemeric Time

THIS IS a method of reckoning time used in astronomical almanacs, which has replaced Universal Time since 1960. Because the Earth's rotation is not completely regular, Universal Time is not uniform. The difference between Ephemeric Time and Universal Time have been as follows :—

Year	E. T. minus U. T. (sec.)
1920	+ 20
1930	+ 23
1940	+ 24
1950	+ 29
1960	+ 34

The Ephemeric Time is based not on the axial rotation of the Earth, but on the Earth's revolution round the Sun.

* * *



Observer's Latitude : 25° N

SEPTEMBER
WEST
KEY - MAP

May	1 at 5 a. m. (I. S. T.)	May	15 at 4 a. m. (I. S. T.)
June	1 at 3 a. m.	June	15 at 2 a. m.
August	1 at 11 p. m.	August	15 at 10 p. m.
September	**1 at 9 p. m.**	**September**	**15 at 8 p. m.**
October	1 at 7 p. m.	October	15 at 6 p. m.

SEPTEMBER : WESTERN SKY

Prominent Stars :

α in Boötes (Arcturus).
α in Corona Borealis (Gemma).
α in Hercules (Ras al Ghetti), red yellow giant.
α in Libra (Zuben el Genuti), lies on the Ecliptic.
α in Lyra (Vega), Pole Star of the future.
α in Scorpius (Antares).
ζ in Ursa Major (Mizar) with companion (Alcor).

Double Stars :

δ, μ in Boötes, seen with a field-glass.
α in Corona Borealis, seen with a 5 cm. telescope.
α in Hercules, orange and green, companion of magnitude 5.
α in Libra, 230″ apart, wide double.
α in Lyra, optical pair 56″ apart, magnitudes 0.2 and 10.5.
ε in Lyra, wide double, 208″ apart, seen with naked eyes.
ζ, β in Lyra, both wide pairs, seen with binoculars.
η in Lyra, 3 small pairs seen in a low power telescope.

Star 70 in Ophiuchus, between η Serpens and β Ophiuchus.
Yellow and red, seen with a 5 cm. telescope.

Special Sight :

δ, μ, ρ, γ, in Hercules are rewarding objects with a 5 cm. telescope.

Variable Stars :

β in Lyra, representative and type, period 12.91 days.
δ in Libra, Algol type, varies from magnitudes 4.8 to 6.2.

Nebulae and Star Clusters :

M 13 (NGC 6205) in Hercules between η and ζ, seen with a field-glass.
M 92 (NGC 6341) in Hercules beyond π, in line with α, δ, π; seen with naked eyes.
M 10 (NGC 6254) ; M 12 (NGC 6218) ; M 19 (NGC 6273) in Ophiuchus, all very faint.
M 5 (NGC 5904) in Serpens near α, very bright, seen with naked eyes.
NGC 6633 in Serpens near θ, really belonging to Ophiuchus, seen with a field-glass.
M 4 (NGC 6121) in Scorpius near α, bright and globular.
M 6 (NGC 6405) in Scorpius, above its tail-end, like a butter-fly.
M 7 (NGC 6475) in Scorpius, brilliant open cluster. seen with naked eyes.

* * *

Red Sunset

IT IS common knowledge that the sky in the west appears red at sunset. The Red Sunset results, as does the Blue Sky, from the fact that the Earth's atmosphere scatters blue light more than red light. Near sunset or sunrise, the Sun's rays, slanting through a long atmospheric path, have nearly all the blue light scattered out of them. Consequently, there is only red and yellow light left in the direct beams. Hence the red colour of the Sun's disc. Further such light as illuminates the clouds is also mainly of this colour.

* * *

Observer's Latitude : 25° N

SEPTEMBER ZENITH NIGHT-SKY

May	1 at 5 a. m. (I. S. T.)	May	15 at 4 a. m. (I. S. T.)
June	1 at 3 a. m.	June	15 at 2 a. m.
August	1 at 11 p. m.	August	15 at 10 p. m.
September	**1 at 9 p. m.**	**September**	**15 at 8 p. m.**
October	1 at 7 p. m.	October	15 at 6 p. m.

Proper Motions of Stars

THE MOTION of the Sun among the stars is quite obvious, but the stars among themselves do not appear to have any motions, because there are no obvious changes in their relative positions. Since ancient times astronomers have, however, attempted to note down the appearances of the night-sky on maps. All such information was later compiled into star catalogues. Hipparchus, in ancient times, recorded about 1000 stars and then compared his own observations with those of his predecessors. He discovered that there were certain changes in the apparent positions of the stars. The reason for this change was found out to be the change in the direction of the Earth's axis, known as Precession. (See pages 23, 25, 51, 55, 179).

After about a thousand years, British astronomer Halley found out that some stars actually changed their places to such an extent that the slow and periodic change of the direction of the Earth's axis failed to account for the change. These real differences were evidently due to 'proper motions' of the stars themselves.

It was estimated, from the comparisons of positions of stars as recorded in actual observations over a period of about 2000 years, that : Aldebaran (α of Taurus-Hyades) had moved 6′ or about 1/5th of the diameter of the Moon as seen from the earth ; Sirius (α of Canis Major) had moved by 45′ or $1\frac{1}{2}$ diameters of the Moon and Arcturus (α of Boötes) by as much as 80′ or nearly three diameters of the Moon.

Observations of any kind of the positions of stars are difficult without a telescope and taking very accurate measurements of Right Ascensions and Declinations (co-ordinates) of the Stars, with a view to determine their actual positions in the sky, are more difficult still. With the improvements in Telescopes and with the increased precision of measuring instruments, particularly for measuring angular distances, astronomical records reached a very high standard. By the end of the 19th century, official publications of star catalogues were able to list positions of as many as 150,000 stars. A close and careful examination of these and subsequent records has now revealed that some 300,000 stars have proper motions.

These motions of stars are not quite at random. There are many systematic trends found all over the sky. For instance, stars in the neighbourhood of the Sun have a tendancy to move towards one direction in space. It is necessary to remember in this connection that our observations are partial, in the sense that we ourselves belong to the solar system. Ideal condition would be to be able to take the observations from outside our galaxy, the Milky Way.

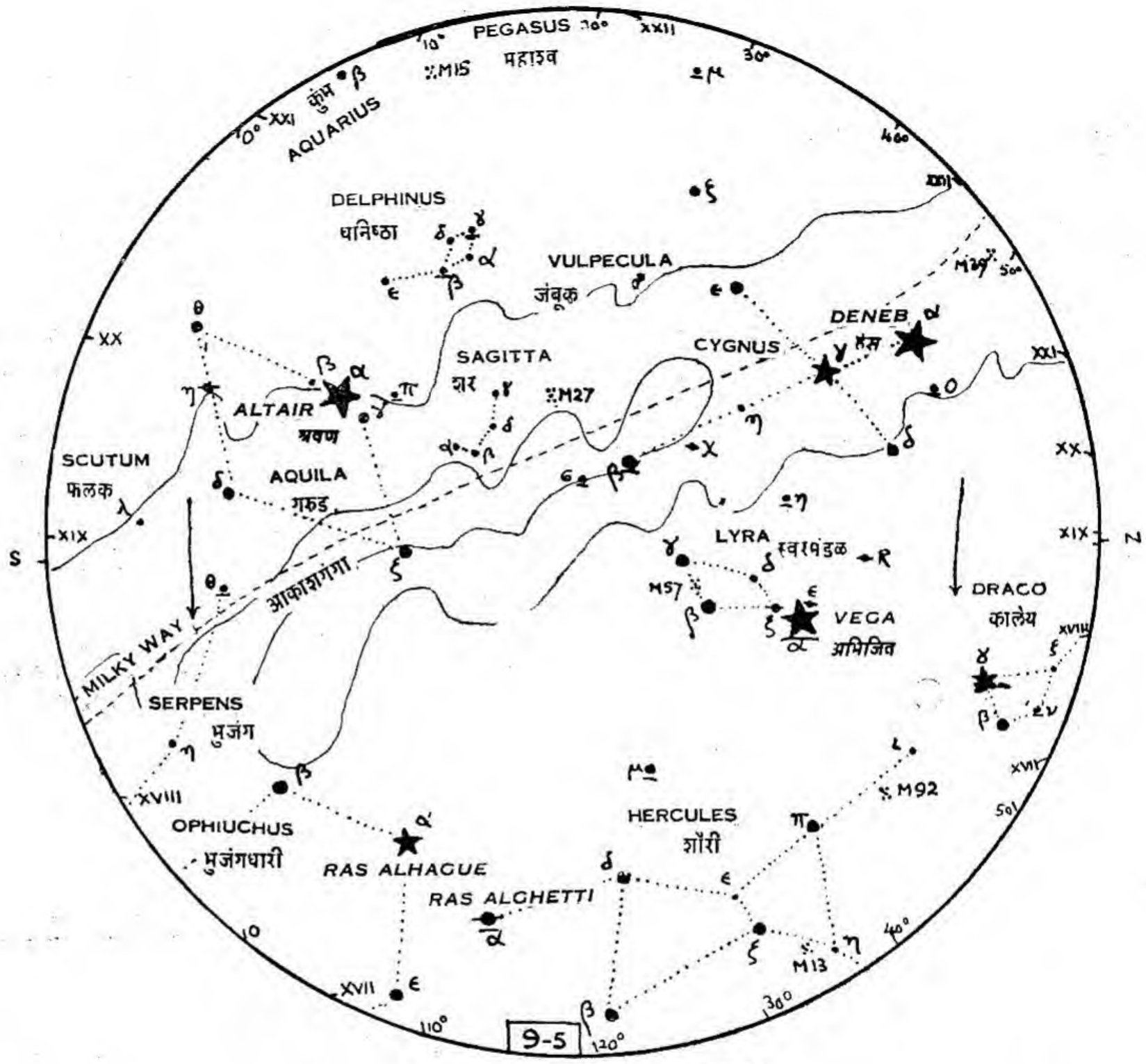
It is now believed that stars belong to different groups according to their structures and evolution and perhaps also according to differences in their chemical compositions. To give just one example, it is now established that all the bright stars of Ursa Major, except α and η travel together as a group, of which the other members are Sirius (α of Canis Major), β of Auriga and α in Coma Berenices. The entire constellation of Ursa Major will, after about 100,000 years, change its shape beyond recognition. (See page 81 column 2 for changing shape of Ursa Major.) (See also Doeppler's Effect at page 193).

* * *

Coelostat

IN THIS instrument, (pronounced 'S e e l o s t a t , ') there is a combination of one moving and one fixed mirror. The moving mirror is mounted parallel to the Earth's axis and is rotated about that axis at one revolution per two days, Light from a star or, more particularly, the Sun, is than reflected in a fixed direction. The second mirror intercepts this beam and can be used to direct it to fixed observing equipment, as required.

* * *



Observer's Latitude : 25°N

SEPTEMBER ZENITH KEY-MAP

May	1 at 5 a. m. (I. S. T.)	May	15 at 4 a. m. (I. S. T.)
June	1 at 3 a. m.	June	15 at 2 a. m.
August	1 at 11 p. m.	August	15 at 10 p. m.
September	**1 at 9 p. m.**	**September**	**15 at 8 p. m.**
October	1 at 7 p. m.	October	15 at 6 p. m.

Receding and Approaching Stars

(Doeppler's Principle)

WHEN WE define the position of a star in the sky by giving its co-ordinates, viz. the Right Ascension and the Declination, we can only fix the direction in which to look for the object. All the stars in that direction, near as well as far off, will have the same Right Ascension and Declination values. The location in space of the stellar object is not, therefore, fully determined merely by these co-ordinates.

The motion of the stellar object across the line of sight is observable without much difficulty, but the motion in the direction of the sight, otherwise called the radial velocity, is not obvious and therefore more difficult to measure. Objects endowed with some motion across the line of sight will trace out lines instead of points on a photographic plate after sufficiently long exposure. Instead of giving one long exposure at a time, it is customary to take photographs at long intervals and compare them. For instance, if any stellar object pictured on the photographic plates has a velocity across the line of sight, the same will be shown at its displaced position. Stars having a radial velocity will not suffer any such displacement on the photographic plate. The motion of a star can be mainly of three types. Either the object appears to be stationary, which means there is no radial motion at all. It will, however, be either approaching us or it will be receding from us. The stars are, indeed, so far away from us that a movement in the radial direction will not cause an appreciable change in their brightness, either way.

A very remarkable and also very reliable method of estimating the radial motion is based on the examination of the lines in the spectrum of the light reaching us from the star. The principle which makes this method possible is based on what is known as Doeppler's Effect, first discovered in acoustics. If a train is rushing towards us, while we are waiting on a railway platform, the whistle appears to have a higher pitch than when the train is stationary. Similarly, if the train is going away from us, the whistle is found to have a lower pitch. Translated in terms of 'frequencies and wave-lengths', therefore, we can say that an approaching source of sound and / or light appears to have a higher frequency and shorter wave-length than when it is stationary.

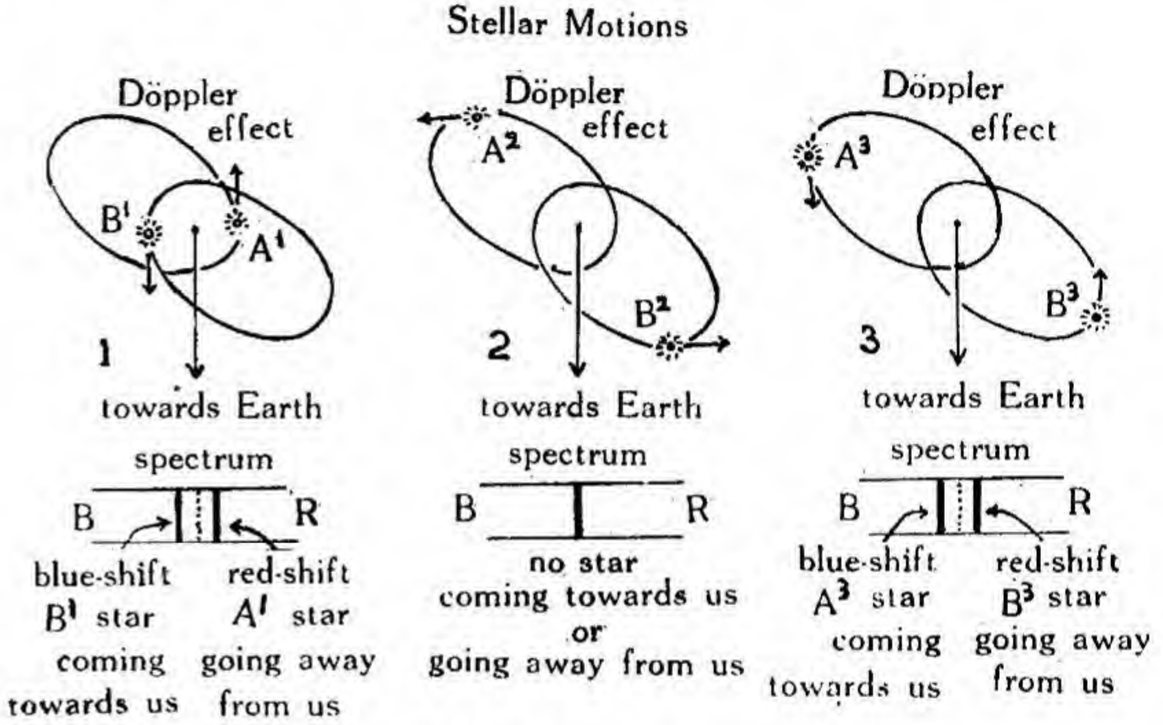


Fig. 9.8 Döppler's effect

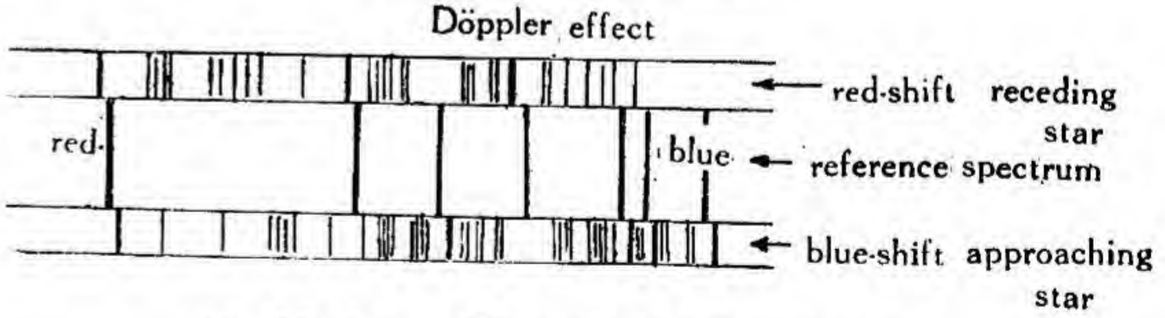
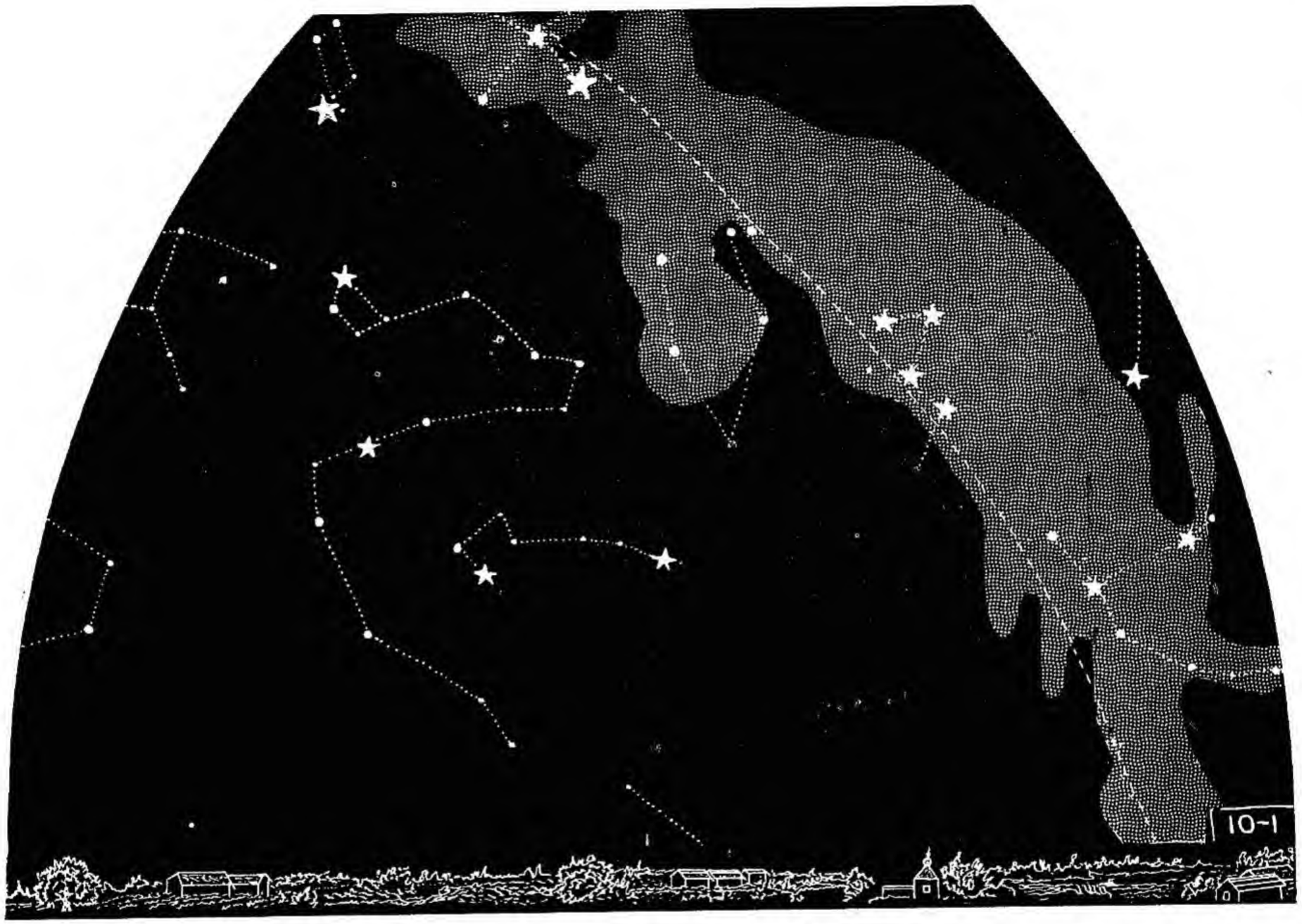


Fig. 9.9 Spectraof approaching and receding stars

The changes in the observed wave-lengths of light, from a moving source, can be easily visualised as 'shifts' in the spectral lines and the same are explained by means of the above figures.

(Continued on Page 197, Column 2)



Observer's Latitude : 25° N

OCTOBER
NORTH
NIGHT-SKY

June	1 at	5 a. m. (I. S. T.)	June 15 at 4 a. m. (I. S. T.)
July	1 at	3 a. m.	July 15 at 2 a. m.
September	1 at	11 p. m.	September 15 at 10 p. m.
October	**1 at**	**9 p. m.**	**October 15 at 8 p. m.**
November	1 at	7 p. m.	November 15 at 6 p. m.

Cepheus

FACING NORTH at 8 p. m. in the middle of october, the constellation can be seen above the Pole Star, with Cassiopeia on the right and Draco on the left. Although there is no particularly bright star in the group, Cepheus is not difficult to locate.

We are not able to see this constellation when it is below the Pole Star, since we are, generally, near Latitude 25° North. The pictorial appearance of Cepheus is like a square with a triangle attached to it at the base, with its apex turned towards the Pole Star. It can also be described as a funnel, the broad end of which is made by the stars α (Alderanin) and ζ (Alphirk), while the star γ (Al Rai) is at the bottom tip of the funnel.

In Indian astronomy, the constellation is called *Vṛṣaparvā* (वृषपर्वा). He was a powerful king and son of sage *Kāśyapa* (काश्यप). His daughter was the beautiful *Śarmiṣṭhā* (शर्मिष्ठा) who was subsequently married to king *Yayāti* (ययाति). This is a very popular narrative and the same has been more fully given under the description of Andromeda, a constellation known as *Devayānī* (देवयानी) in Indian astronomy.

The legend of King Cepheus is mentioned in Greek literature as old as 5th century B. C. The king following the advice of an oracle, had preferred to sacrifice his own daughter Andromeda by chaining her to a rock on the sea-shore. He was made to believe that by making this supreme sacrifice he would be able to appease the anger of Neptune, the Sea-God. The cause of Neptune's anger was considered to be the excessive vanity of the queen Cassiopeia who had displeased him. Neptune, therefore, attempted to seek revenge on the kingdom of Cepheus by sending disasters like storms and wrecks. At this stage the oracle was consulted. While the population was praying for the safety of their princess, Perseus, the hero, appeared on the scene and destroyed all the sea-monsters with his sword and released Andromeda from her bondage.

There is considerable similarity in the legends about Cepheus. The Greek and Indian names are : Cepheus : *Vṛṣaparvā* (वृषपर्वा). Cassiopeia* : *Śarmiṣṭhā* (शर्मिष्ठा), Andromeda** : *Devayani* (देवयानी); and Perseus***: *Yayāti* (ययाति). It has often been suggested that one legend must have been adopted from the other, but as to which was the original and which the adaptation is not clear.

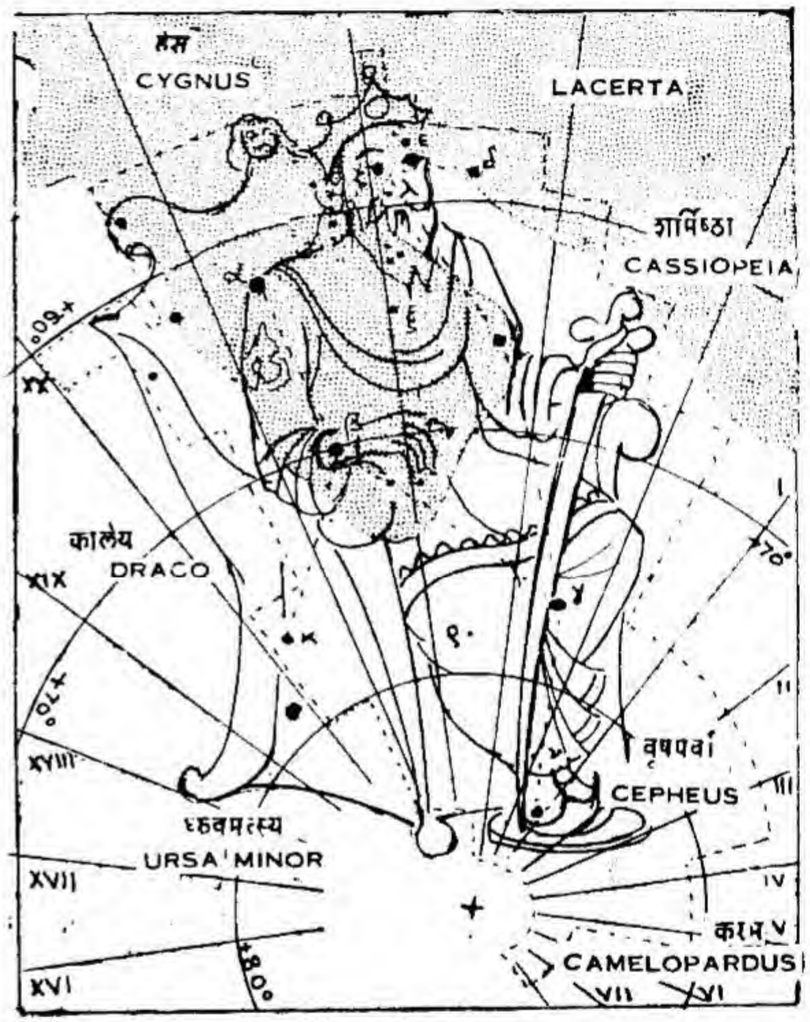


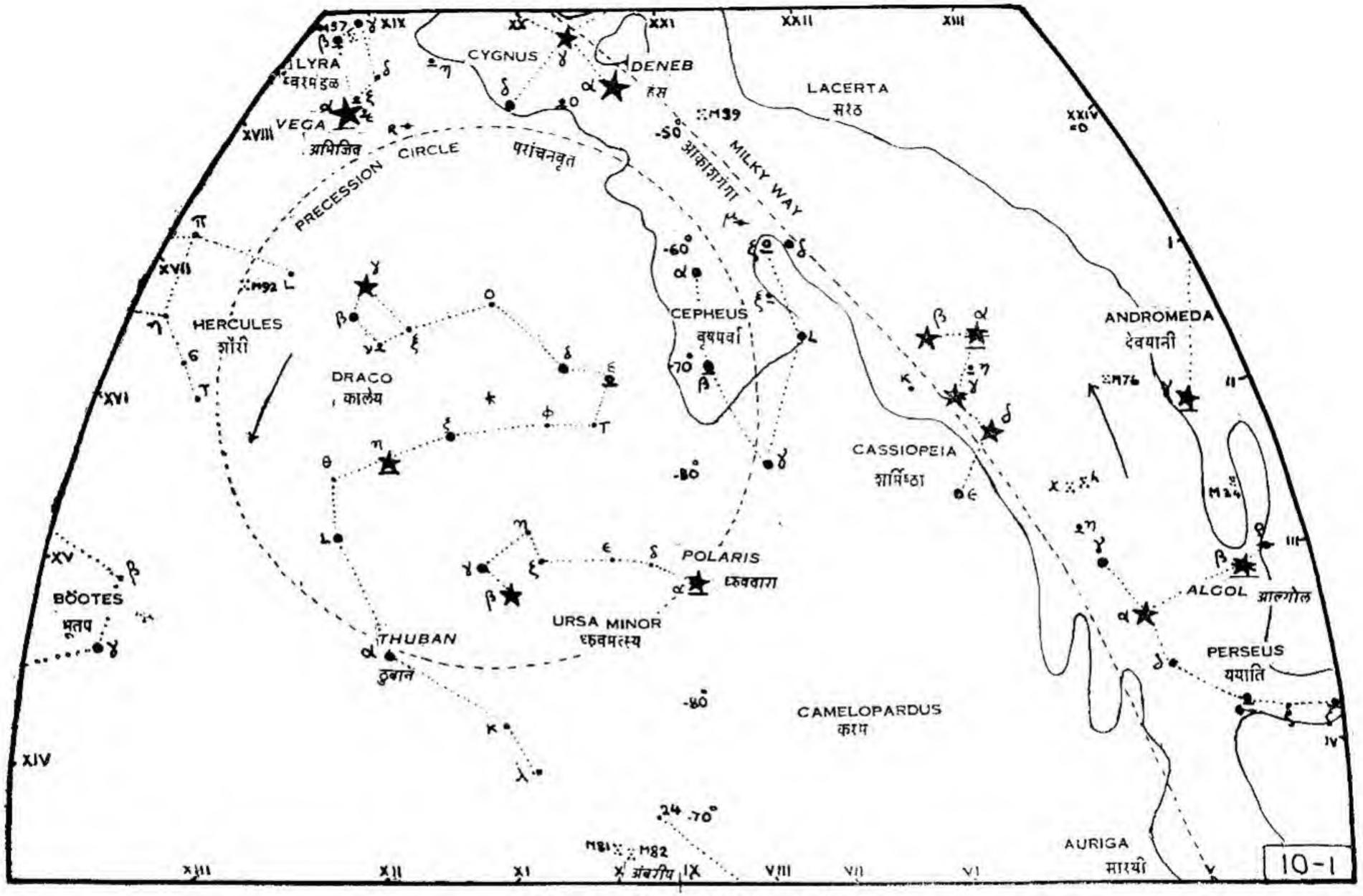
Fig. 10.1 : Cepheus (Vṛṣaparvā)

* See *Cassiopeia* at page 215.

** See *Andtomeda* at page 219.

*** See *Perseus* at page 235.

(Continued on Page 201, Column 2



Observer's Latitude : 25° N

OCTOBER
NORTH
KEY-MAP

June	1	at	5 a. m. (I. S. T.)	June	15	at	4 a. m. (I. S. T.)
July	1	at	3 a. m.	July	15	at	2 a. m.
September	1	at	11 p. m.	September	15	at	10 p. m.
October	**1**	**at**	**9 p. m.**	**October**	**15**	**at**	**8 p. m.**
November	1	at	7 p. m.	November	15	at	6 p. m.

OCTOBER : NORTHERN SKY

Prominent Stars :

α, β (Shedar and Caph) and 3 more stars in Cassiopeia forming the letter W or M.

α in Cygnus (Deneb).

α in Draco (Thuban), former Pole Star.

α in Lyra (Vega), future Pole Star.

α, β in Pegasus (Markab and Sheat).

β in Perseus (Algol).

α in Ursa Minor (Polaris), present Pole Star.

Double Stars :

η in Cassiopeia, seen with a 5 cm. telescope.

β, ξ in Cepheus, seen with a 5 cm. telescope.

β, μ, o_2 in Cygnus, seen with a field-glass.

o_2 in Cygnus is really a triplet.

ν in Draco, 2 equally bright stars of 5th magnitude, seen with a binocular.

α in Lyra is an optical pair seen with a binocular.

ζ, β in Lyra, wide pairs, seen with a binocular.

σ in Lyra, wide double 208" apart, seen with naked eyes.

η in Lyra, 3 small pairs seen in a low-power field-glass.

α in Ursa Minor, wide double 18" apart, seen with a 5 cm. telescope.

Variable Stars :

δ in Cepheus, a type, varies from 3.6 to 4.2 magnitudes, period 5.37 days.

χ in Cygnus, Mira type, varies through 10 magnitudes.

β in Lyra, a representative with period of 12.91 days.

Super Nova :

This occurred in Cassiopeia in 1572 A. D., was as bright as Venus, seen by day and ceased to be visible in 1574 A. D.

Nebulae and Star Clusters :

M 39 (NGC 7092) in Cygnus beyond α and near π^2. Open cluster seen with a field glass.

In Cygnus there is a very strong source of radio emission.

M 57 (NGC 6720) 'Ring Nebula' in Lyra, about half-way on the line connecting β and γ. Seen only through a telescope.

M 81 (NGC 3031) and M 82 (NGC 3034) in Ursa Major. Seen very near the horizon in the month of October. Both can be observed through a low power telescope.

* * *

(Continued from Page 193, Column 2)

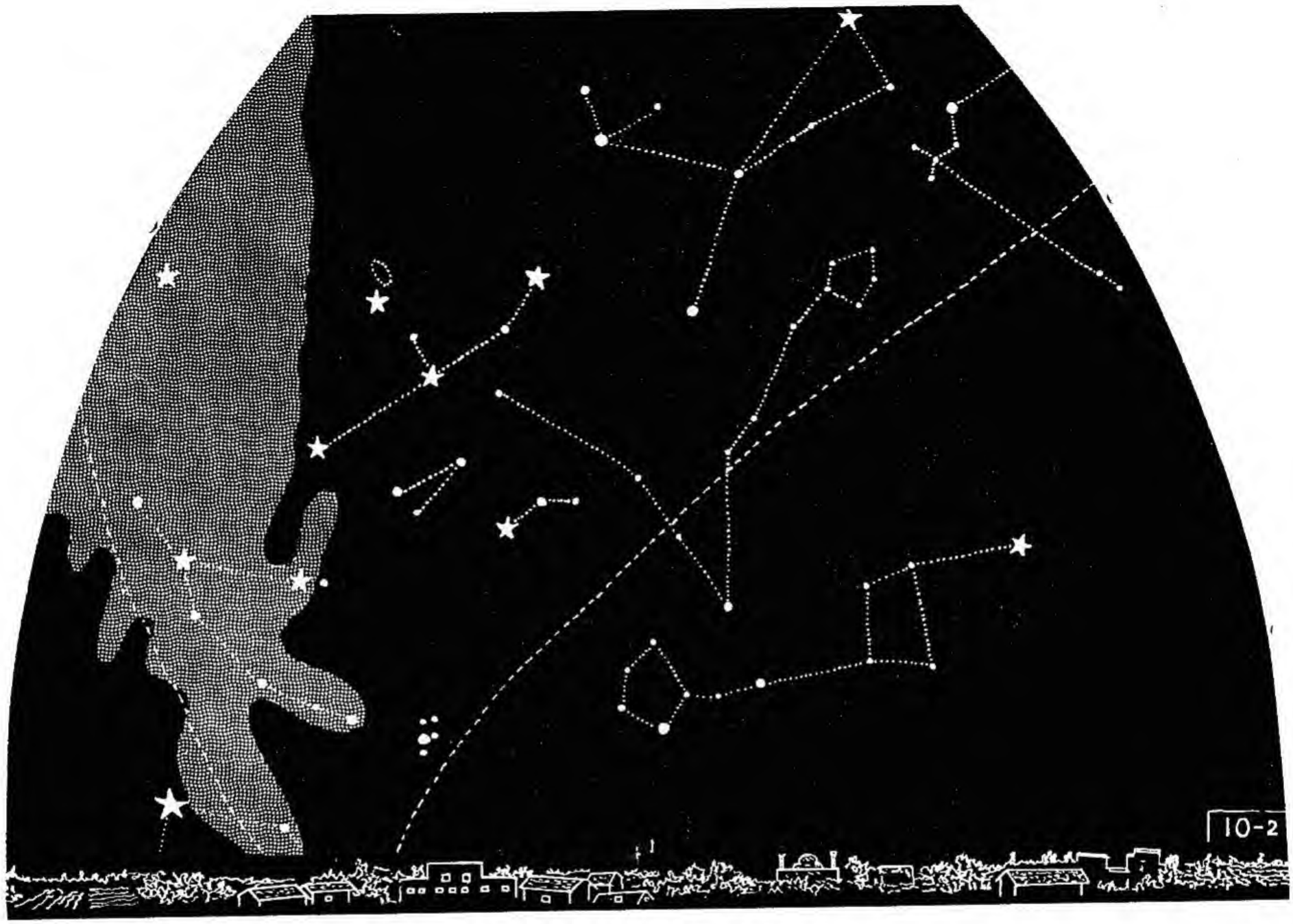
Receding and Approaching Stars

Pitch corresponds to the frequency of the waves, or the number of waves per second reaching the observer. When a source of light approaches us, we receive more waves per second than when there is no relative motion. The frequency of light of an approaching star will, thus, appear to be greater. Similarly the frequency of a star receding from us will appear to be less than when the star has no radial motion at all. This is known as the Doeppler's. Effect ((See Fig. 9.8 and 9.9 on page 193)

When light is split up by means of a spectroscope, we see several lines in the spectrum which are peculiar to the light from the source. If these lines show a displacement towards the red end, the occurrence is described as a 'red shift'. It means a longer wavelength or decreasing frequency, indicating a movement of the source away from us. This is the case of a star receding. On the other hand, if the shift of the spectral lines is towards violet, it corresponds to an increase of frequency, giving evidence that the source is approaching us. From the amount of the shift, the radial velocity can be evaluated.

If a star has a radial velocity of 100 Km. per sec, the spectral lines are displaced by 1.67 Å at a wavelength of 5000 Å. ($1\,Å = 10^{-8}$ cm)

* * *



Observer's Latitude : 25° N

OCTOBER
EAST
NIGHT-SKY

June	1 at 5 a. m. (I. S. T.)	15 at 4 a. m. (I. S. T.)
July	1 at 3 a. m.	15 at 2 a. m.
September	1 at 11 p. m.	15 at 10 p. m.
October	**1 at 9 p. m.**	**15 at 8 p. m.**
November	1 at 7 p. m.	15 at 6 p. m.

Pegasus

FACING EAST at about 8 p. m. in the middle of October, we see the white band of the Milky Way in the north-east corner, going upwards from the horizon. We also see, on the left-hand side, Cepella (α in Auriga) just on the point of rising, then Algol (β in Perseus), the W shaped Cassiopeia and Deneb (α in Cygnus) high up in the Milky Way. The constellation Pegasus occupies a prominent place in the centre of the eastern sky and it is almost in line with Cepheus on one one side and Aquarius on the other.

Pegasus is a Greek word, ' Pega ' means a bridle and ' sus ' means a horse. According to Greek mythology, when Perseus, the warrior, swooped down and cut off the head of Gorgon, the blood dripping from the head got mixed up with the waters of the sea. Seeing this, Neptune spun the same into slivers with wind and waves and created out of it the wonderful Winged Horse which we now know as Pegasus. Full-grown and gifted with immortal life the horse was lifted to the skies and it is now retained there as a constellation. It is said further that when Perseus* rushed to save Andromeda** from the fury of the sea-monsters he had used the same horse.

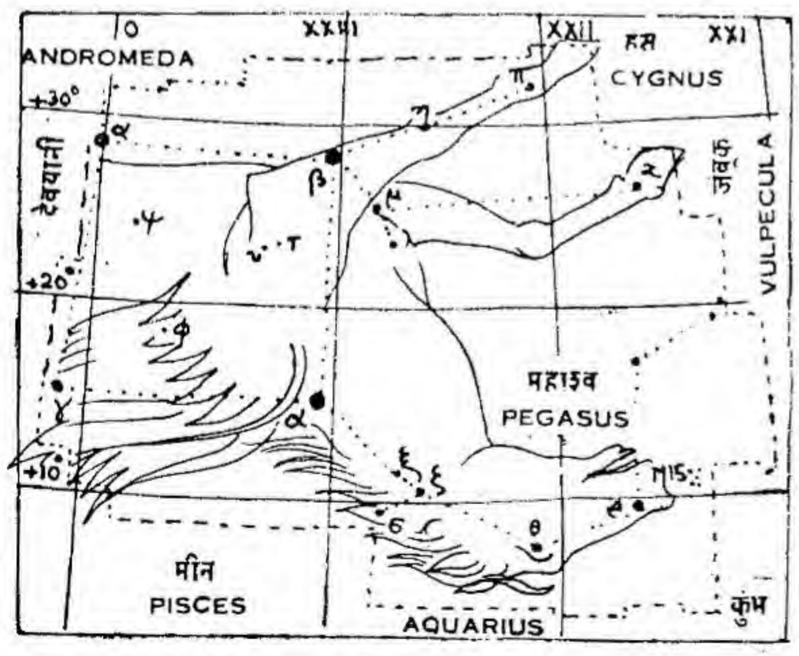


Fig. 10.2 : Pegasus.

There is a corresponding story in Indian mythology, according to which, horse with seven heads was aquired by the Gods out of the great operation known as the ' Churning of the Oceans '.

Pegasus is an ancient constellation and easy to locate. Its prominent stars are α (Markab), β (Sheat) and γ (Algenib). They form three corners of a rectangle. At the fourth corner we find the bright star α of Andromeda, which is known as Alpheratz or Sirrah. If we extend the line joining this star α of Andromeda with γ of Pegasus by its own length, we reach the very important point known as the Vernal or Spring Equinox. This is the intersection of the Celestial Equator with the Ecliptic. The Ecliptic is the Sun's apparent path in the sky among the stars. When the Sun reaches the Vernal Equinoxial point the length of the day is equal to the length of the night, and that day is 21st of March.

The bright stars α and β are very near the Great Circle representing the Hour-Angle XXIII. These two stars form one side of the rectangle of Pegasus. The other side, as previously mentioned, is formed by the star γ of Pegasus and α of Andromeda. These last two stars are very near the Great Circle representing Hour-Angle 0.

Although there are not many stars inside the square of Pegasus, we can still, with some effort, see with naked eyes about 50 stars. Near the north-east corner, three stars form a triangle with the bright star β (Sheat).

On the western side of Pegasus, there is a row of 3rd and 4th magnitude stars. There are also so many Nebulae in this region that Mount Wilson Observatory is reported to have recorded as many as 162 separate Nebulae in a very small area but they are very very far away from us. It is estimated that the distance is of the order of 100 million light-years.

The star β is a variable. There is a globular and brilliant Nebula known as M 15 near the star ε. It is not visible to the naked eye and it is about 42,000 light-years away from us. β (Sheat) a nd α (Markab) are known as Pūrvā Bhādrapadā and γ (Al genib) is known as Uttara Bhādrapadā. ε is (Fom or Enif). The other star ζ is called Homam or Homan.

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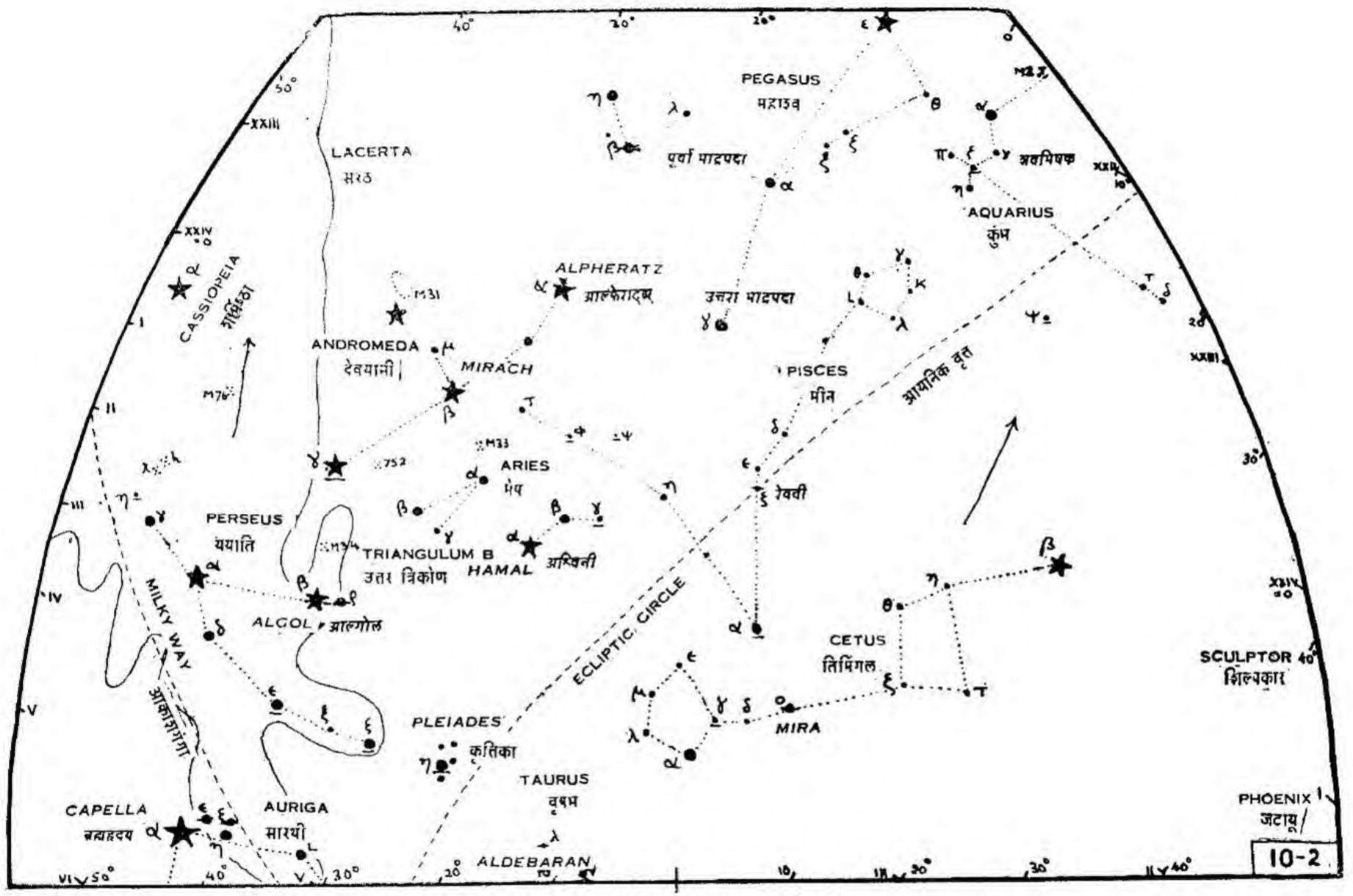
* See *Perseus* at page 235

** See *Andromeda* at page 219

* * *



Observer's Latitude : 25° N

OCTOBER
EAST
KEY-MAP

June	1 at 5 a. m. (I. S. T.)	June	15 at 4 a. m. (I. S. T.)
July	1 at 3 a. m.	July	15 at 2 a. m.
September	1 at 11 p. m.	September	15 at 10 p. m.
October	**1 at 9 p. m.**	**October**	**15 at 8 p. m.**
November	1 at 7 p. m.	November	15 at 5 p. m.

OCTOBER : EASTERN SKY

Prominent Stars :

α, β, γ in Andromeda (Alpheratz, Mirach, Almach).
α in Aries (Hamal).
α in Auqarius (Sad-al-melic).
α in Auriga (Capella).
α, β, o in Cetus (Menka, Diphda, Mira).
α, β in Pegasus (Markab and Sheat).
η in Taurus - Pleiades (Alcyone).
β in Perseus (Algol).

Double Stars :

γ in Andromeda, gold and blue, seen through a small telescope.
ψ_1 in Aquarius, nice double for a field-glass.
γ in Arles, interesting double for a 5 cm. telescope.
β in Perseus. Eclipsing binary, known since 300 years ago. It has 2 more components, making it a quadruple.
ε, ζ, η in Perseus, seen with a 5 cm. telescope.
ψ_1, ζ in Pisces, easily resolvable doubles.
η in Taurus-Pleiades, bright and wide double. About 20-30 stars, seen with a binocular.

Variable Stars :

o in Cetus (Mira), changes from 1-7 to 9.6 magnitudes. That means brightness changes by a factor 2100. This was the first variable star discovered.

β in Perseus, regularly variable, period 2 days 20 hours 48.9 min.

Super Nova :

This had appeared in Cassiopeia in 1572 A. D., and disappeared in 1574 A. D. It looked as bright as Venus.

Nebulae and Star Clusters :

M 31 (NGC 224) in Andromeda near ν, long oval shaped, seen with naked eyes. This is extra-galactic and receding.

NGC 752 in Andromeda near γ, large and open.

M 2 (NGC 7089) in Aquarius near β, seen with naked eyes.

M 76 in Perseus near φ. Dumb-bell shaped. This belongs to our galaxy.

h (NGC 869) and χ (NGC 884) in Perseus, bright beautiful diffuse spots with naked eyes.

Faint Nebula NGC 1435 in Taurus-Pleiades near 'Merope' seen in a view-finder.

M 33 (NGC 598) in Triangulum near α, seen with a small telescope. This is one of the nearest galaxies.

* * *

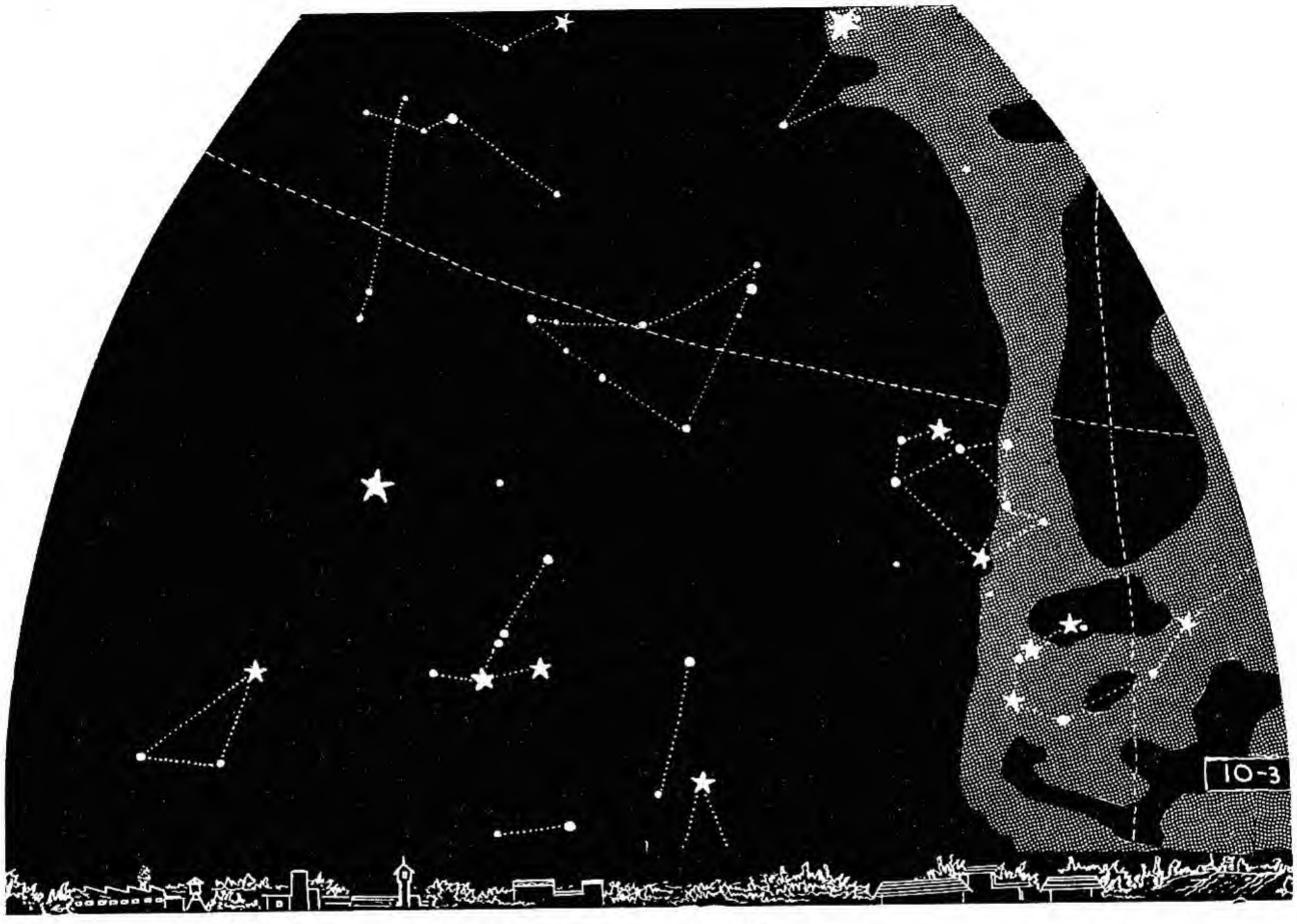
(Continued from Page 195, Column 2)

Cepheus

Star δ in Cepheus is a typical short period variable. Its magnitude varies from 3.6 to 4.3 and its period is 5.37 days. The rise in brightness from minimum to maximum occurs in about 1.5 days and is, therefore, more rapid than its decline which takes about 4 days. The variation in brightness happens to be the result of pulsations in the atmosphere of the star. This star δ has a partner of magnitude 6.6 and its distance from us is about 340 light-years.

From the neighbourhood of star γ radiate Meteoric showers from 10th June to 28th June and they are called *Cepheid Meteors*

* * *



Observer's Latitude : 25°N

OCTOBER SOUTH NIGHT-SKY

June	1 at 5 a. m.	(I. S. T.)
July	1 at 3 a. m.	
September	1 at 11 p. m.	
October	**1 at 9 p. m.**	
November	1 at 7 p. m.	

June	15 at 4 a. m.	(I. S. T.)
July	15 at 2 a. m.	
September	15 at 10 p. m.	
October	**15 at 8 p. m.**	
November	15 at 6 p. m.	

Aquarius

THIS IS one of the Zodiacal constellations and it is situated astride the Ecliptic. It is also fairly extensive. The constellation generally lies to the east of Capricornus and has, on its periphery, in a clockwise direction, Capricornus, Pisces Austrinus, Cetus, Pisces, Pegasus and Aquila.

At the present time the Sun happens to be in Aquarius during the months of February and March. But in a previous epoch, when the Sun occupied this position for observers in Mesopotamia, it used to be the rainy season and that explains somewhat the pictorial representation of the constellation. The picture gives the scene in the sky as if someone is emptying vessels full of water on the neighbouring constellation of Pisces, the Fish

The legend in Indian mythology of 'Churning of the Ocean' *Samudra-manthana* (समुद्रमंथन) appears to be very suggestive; in as much as in this part of the sky we have, strangely enough, most of the participants in that great task undertaken by the Gods. We have here Pisces (the Fish), Capricornus (The Sea-Goat), Aquila (the Eagle) and Hydra (the Sea-Snake). The rope round the churning pillar in the legend was furnished, by the Snake.

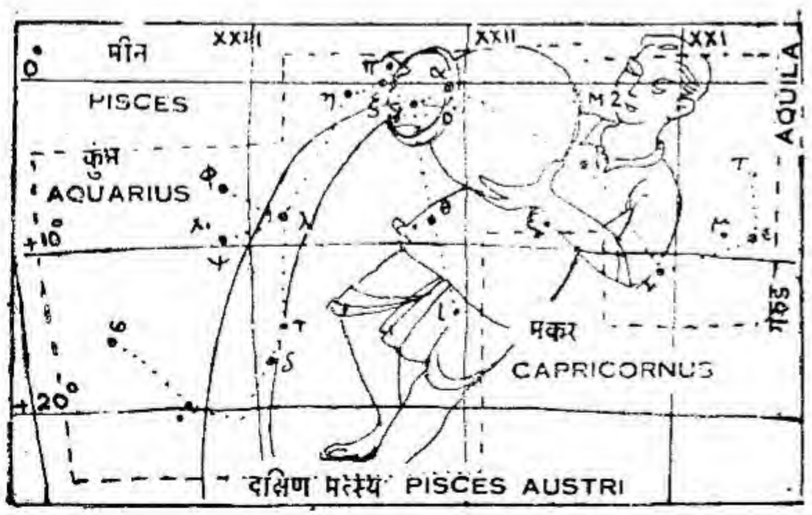


Fig. 10.3 : Aquarius (Kumbha)

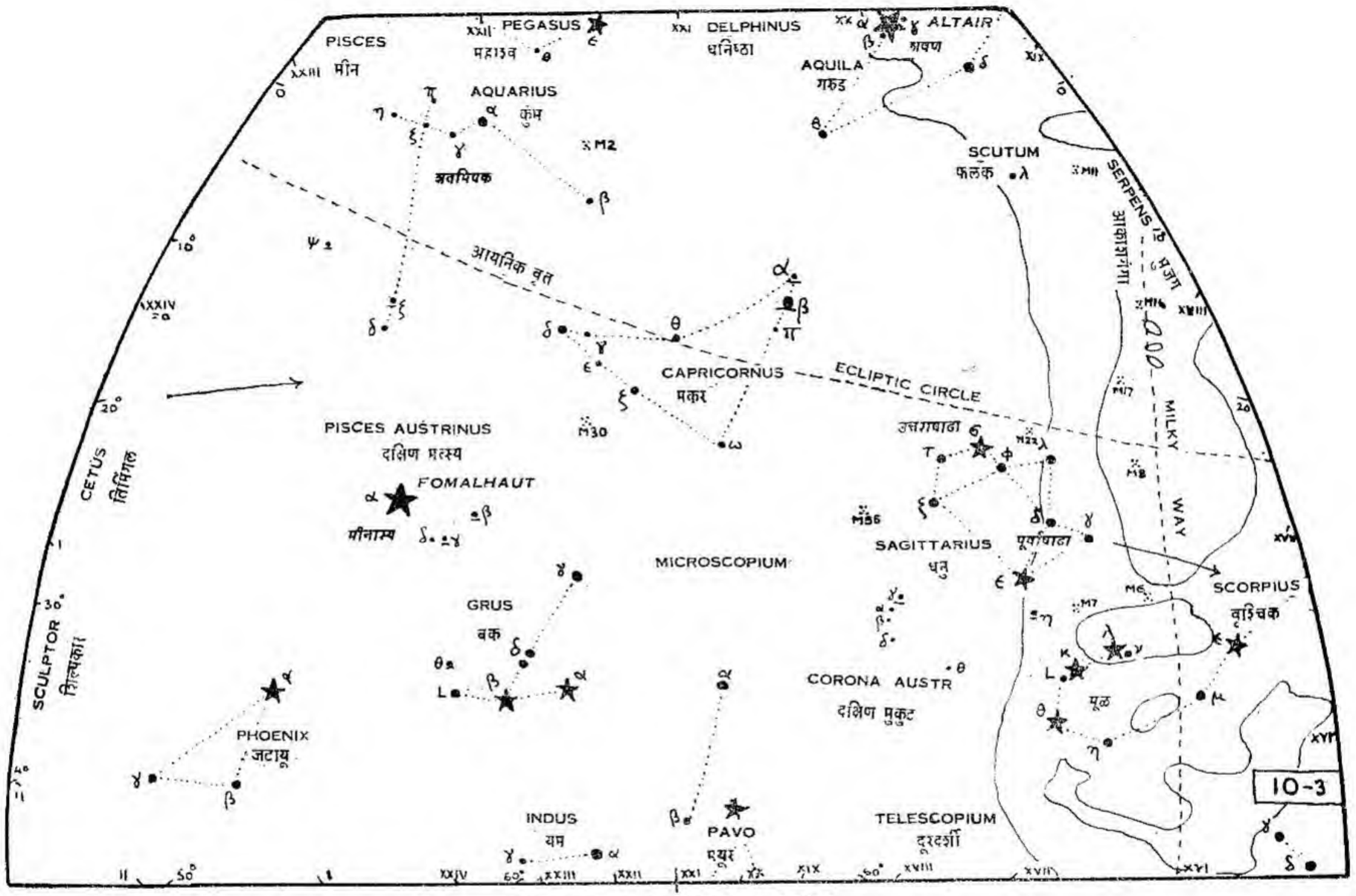
The name Aquarius means the Water-bearer and the origin of this name is believed to be in one legend from Greek mythology. Jupiter had sent an Eagle (Aquila) to kidnap a beautiful shepherd youth named Ganymede. The youth was carried to the abode of Gods against the wishes of his father. In this affair, Jupiter had to console the grieving father of Ganymede by giving him a pair of divine horses, and had to reward the young Ganymede by placing him among the constellations, as Aquarius the Cup-bearer. It is believed that the cup contained Nectar instead of plain water.

Aquarius lies to the east of Aquila.

The names of the stars in Aquarius are α (Sad al Malik), β (Sad al Sud), γ (Sadalachiba), known as *Śatabhiṣak* (शतभिषक्) in Indian astronomy and δ (Skat).

The star ψ_1 is a nice double and can be observed with field-glasses. There is a star-cluster, known as M 2, near star β of the constellation and under favourable conditions it is visible to the naked eyes also.

* * *



Observer's Latitude : 25°N

OCTOBER SOUTH KEY-MAP

June	1 at	5 a. m.	(I. S. T.)
July	1 at	3 a. m.	
September	1 at	11 p. m.	
October	**1 at**	**9 p. m.**	
November	1 at	7 p. m.	

June	15 at	4 a. m.	(I. S. T.)
July	15 at	2 a. m.	
September	15 at	10 p. m.	
October	**15 at**	**8 p. m.**	
November	15 at	6 p. m.	

OCTOBER : SOUTHERN SKY

Prominent Stars :

α in Aquarius (Sad-al-Malik).

α in Aquila (Altair) known since 1000 B. C.

α in Grus.

α in Pavo.

α in Phoenix.

α in Pisces Austrinus (Fomalhaut).

The tail of Scorpius in the Milky Way in S W lower corner.

Double Stars :

ψ_1 in Aquarius, nice double seen with field glasses.

ζ in Aquarius, seen with a 7.5 or 10 cm telescope.

π in Aquila, seen with a 7.5 cm. telescope.

α_2 in Capricornus, seen only with a 15 cm. telescope.

γ in Delphinus, yellow and emerald, seen with a 5 cm. telescope.

θ in Grus, magnitudes 4.5 and 7.0.

ξ in Pavo, colour contrast, 154″ apart.

β in Pisces Austrinus, 30″ apart, magnitudes 4.4 and 7.8.

Variable Stars :

η in Aquila, Cepheid type, having period of 7.18 days.

Nebulae and Star Clusters :

M 2 (NGC 7089) in Aquarius near β, seen with naked eyes.

M 30 (NGC 7099) in Capricornus near ζ, seen with a field-glass.

M 8 (NGC 6523) in Sagittarius, galactic gaseous nebula with stars embedded. Seen with naked eyes.

M 17 (NGC 6618) in Sagittarius, ' Omega Nebula ', known as Horse-shoe; large and bright.

M 22 (NGC 6656) in Sagittarius between μ and σ. Large, bright and globular.

* * *

(Continued from Page 211, Column 2)

Radio Telescope

The Jodrell Bank radio telescope has a reflector of nearly 69 meters in diameter and it is located near Mancheser, U. K.

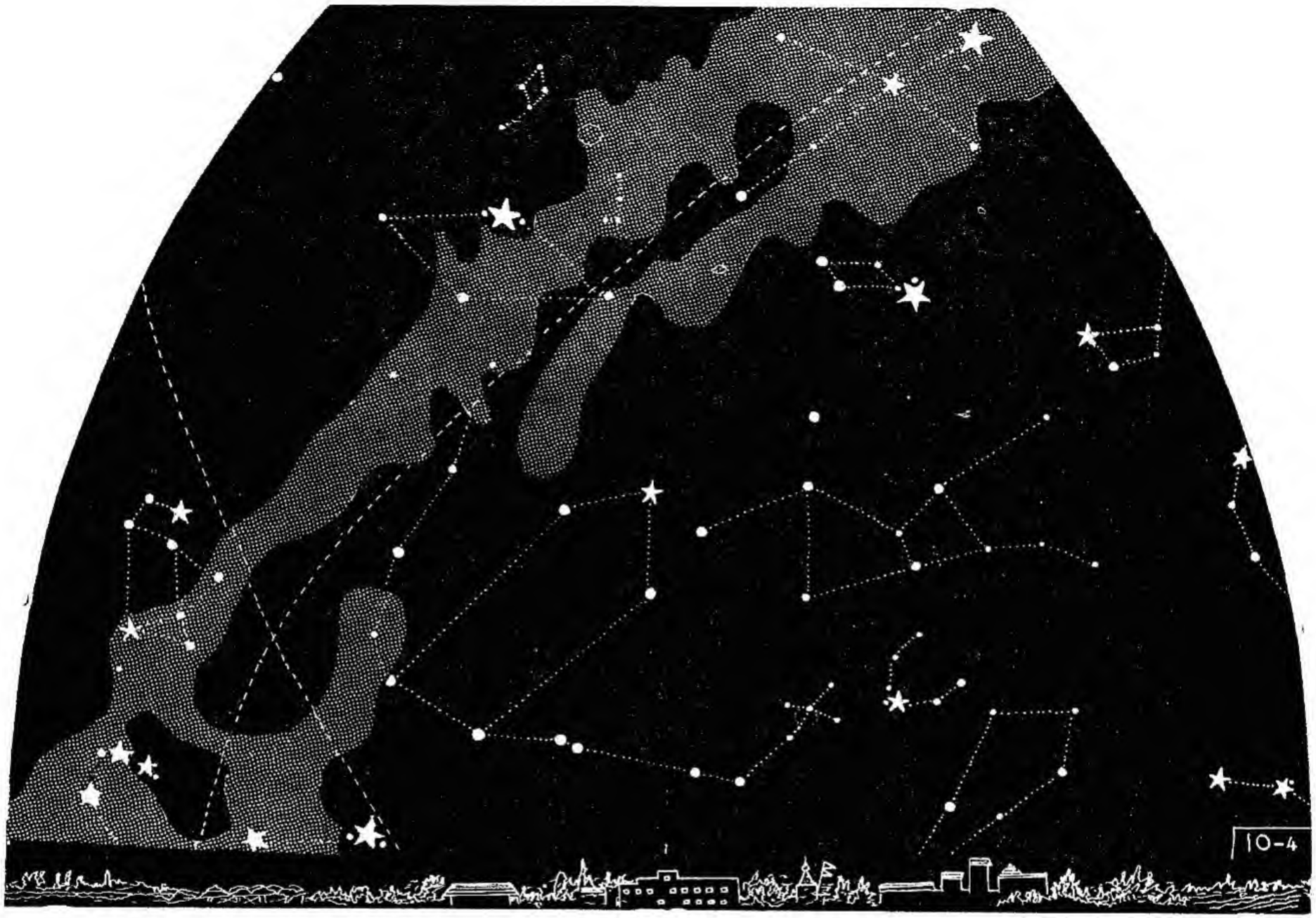
Another large radio-telescopes is in Cambridge, U. K. It has four sections, each in the form of a parabola, with a total receiving area of about 4700 square meters. The telescope has completed survey of more than 2000 discrete radio sources in the northern sky. It is customary now to describe some of these as Radio Stars.

In the United States, a partially moveable antenna nearly 90 meters in diameter is in use at Green Bank, West Virginia.

The World's most powerful radio telescope is a large non-steerable dish, almost 300 metres from rim to rim, near the town of Aeribo, Puerto Rico, West Indies.

There is in India a Radio Telescope, installed in 1973, at Ootaccamund, in the Nilgiri Mountain and it has already detected about 200 radio sources in the sky. This telesccope is ideally suited for the search of Pulsars.

* * *



Observer's Latitude : 25° N

June	1	at	5 a. m. (I. S. T.)	June	15	at	4 a. m. (I. S. T.)
July	1	at	3 a. m.	July	15	at	2 a. m.
September	1	at	11 p. m.	September	15	at	10 p. m.
October	**1**	**at**	**9 p. m.**	**October**	**15**	**at**	**8 p. m.**
November	1	at	7 p. m.	November	15	at	6 p. m.

OCTOBER
WEST
NIGHT-SKY

Norma

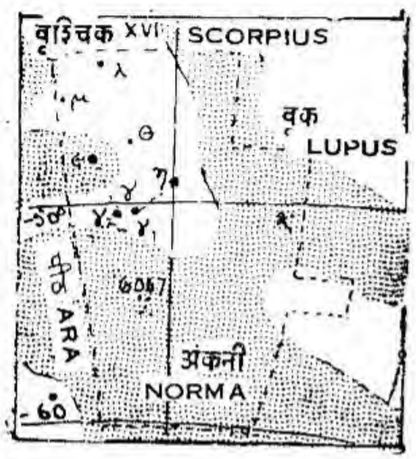


Fig 10.4 : Norma

THIS IS a constellation of the Southern Hemisphere, with a modern name meaning 'level'. Drawing a line through α of Crux, the Southern Cross and α of Centaurus and extending the same towards north-east it meets the only bright star (of magnitude 4) of the constellation Norma. There are some Star Clusters, but they can be observed only with the help of powerful telescopes (See Fig. 10.4: Norma).

* * *

Ara

THE NAME means the Altar. The constellation is situated to the south of Scorpius and according to mythology, Noah is said to have performed his first sacrifice here after being rescued from the great Deluge.

There are 3 stars of magnitude 3 and the others are of magnitudes 4 and 5.

The Open Star cluster in this constellation is about 13,000 light years away from us. (See. Fig. 10.5 : Ara).

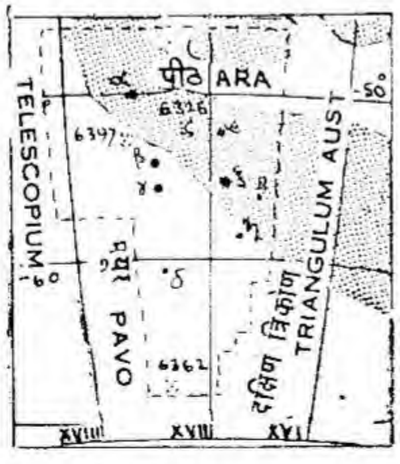


Fig. 10.5 : Ara

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Triangulum Australe

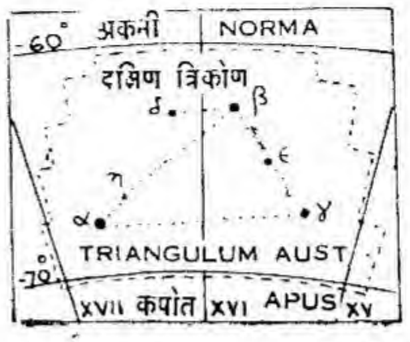

Fig. 10.6 : Triangulum Australe

THIS IS the Triangle of the Southern Hemisphere and it is made up of 3 bright stars to the east of the principal star of Centaurus. The name is modern. There is a bright open cluster (6025) in line γ, ε, β and beyond.
(See Fig. 10.6 : Triangulum Australe).

* * *

Apus

THE CONSTELLATION represents a bridge of paradise. It is situated to the south of the Southern Triangle and being beyond 70 S, it remains invisible to us. There are 4 bright stars in a row. The last one is a double resolvable with a small telescope. (See Fig. 10.7 : Apus.)

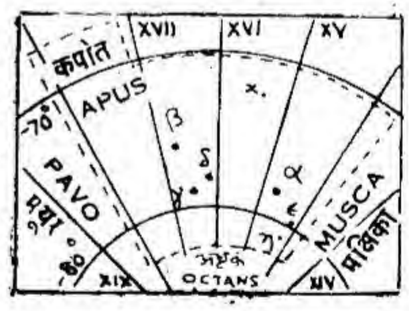

Fig. 10.7 : Apus

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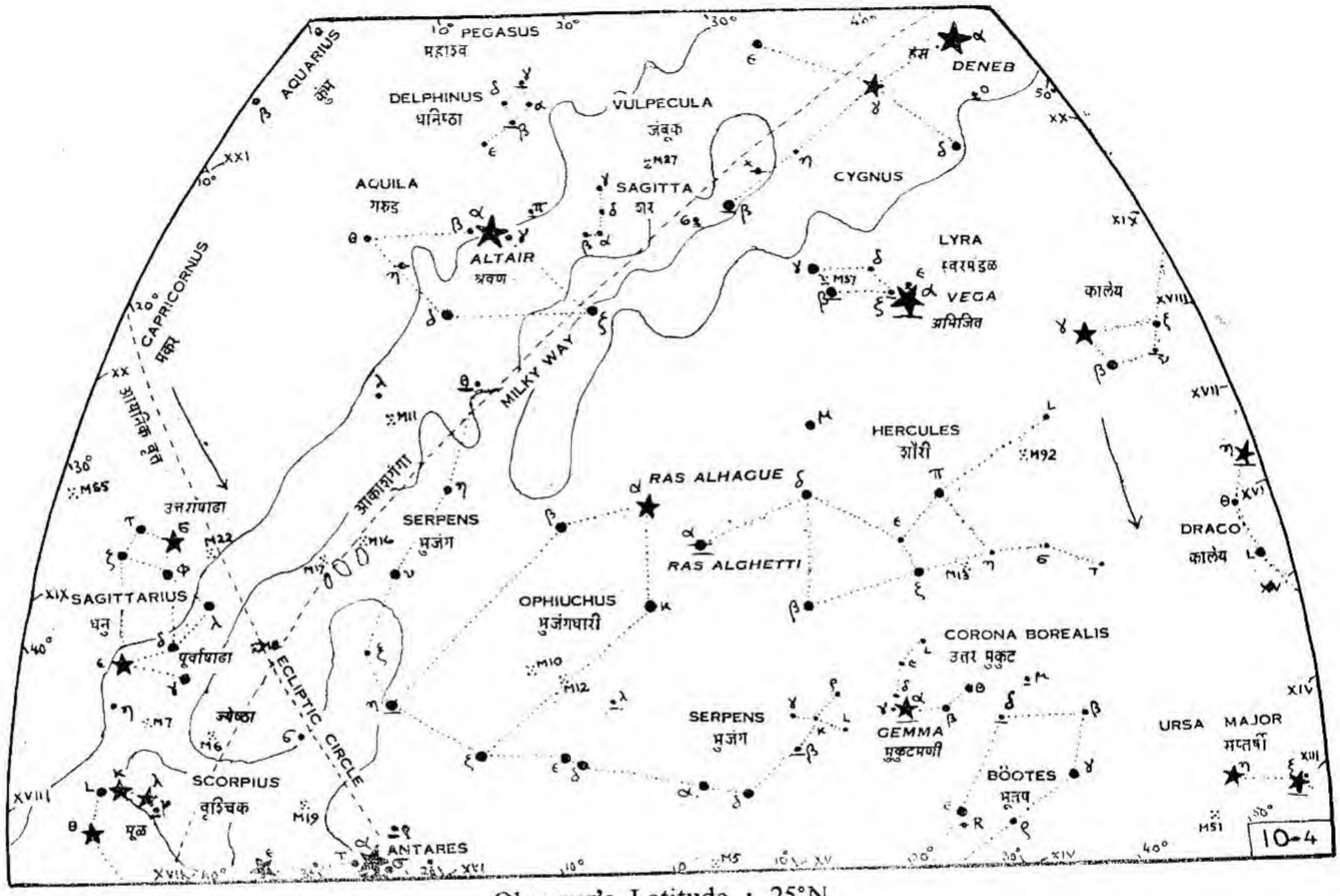


Observer's Latitude : 25°N

OCTOBER
WEST
KEY-MAP

June	1 at	5 a. m.	(I. S. T.)
July	1 at	3 a. m.	
September	1 at	11 p. m.	
October	**1 at**	**9 p. m.**	
November	1 at	7 p. m.	

June	15 at	4 a. m.	(I. S. T.)
July	15 at	2 a. m.	
September	15 at	10 p. m.	
October	**15 at**	**8 p. m.**	
November	15 at	6 p. m.	

OCTOBER : WESTERN SKY

Prominent Stars :

α in Aquila (Altair).

α in Corona Borealis (Gemma).

α in Cygnus (Deneb).

α in Hercules (Ras AlGhetti), red yellow giant.

α in Lyra (Vega).

α in Ophiuchus (Ras al Hague).

α in Scorpius (Antares).

Double Stars :

π in Aquila, seen with a 7.5 cm. telescope.

α in Hercules, 5th magnitude, orange and green pair.

α in Corona Borealis, well known double for a 5 cm. telescope.

α in Lyra, optical pair 56″ apart, 0.2 and 10.5 magnitudes.

ε in Lyra, wide double 208″ apart, seen with naked eyes.

ζ, β in Lyra, wide pairs seen with binoculars.

η in Lyra, 3 small pairs, seen with low power telescope.

θ in Serpens (tail-star), seen with field-glasses.

Variable Stars :

η in Aquila, Cepheid type, period 7.18 days.

α in Hercules, varies from 3.1 to 3.9 magnitudes.

β in Lyra, representative, period 12.91 days.

Nebulae and Star Clusters :

M 13 (NGC 6205) in Hercules seen with naked eyes.

M 92 (NGC 6341) in Hercules beyond π, seen with naked eyes.

M 10 (NGC 6254), M 12 (NGC 6218), in Ophiuchus on the line connecting β and δ.

M 19 (NGC 6273) in Ophiuchus, perpendicular to the line η, ζ, θ.

NGC 6633 in Serpens near θ, but belonging to Ophiuchus, seen with a field-glass.

M 17 (NGC 6618) in Sagittarius, ' Omega Nebula '.

M 8 (NGC 6523) in Sagittarius, ' Lagoon Nebula ', with stars embedded, seen with naked eyes.

M 5 (NGC 5904) in Serpens near θ, bright and seen with naked eyes.

M 7 (NGC 6475) in Scorpius, brilliant cluster, visible to naked eyes.

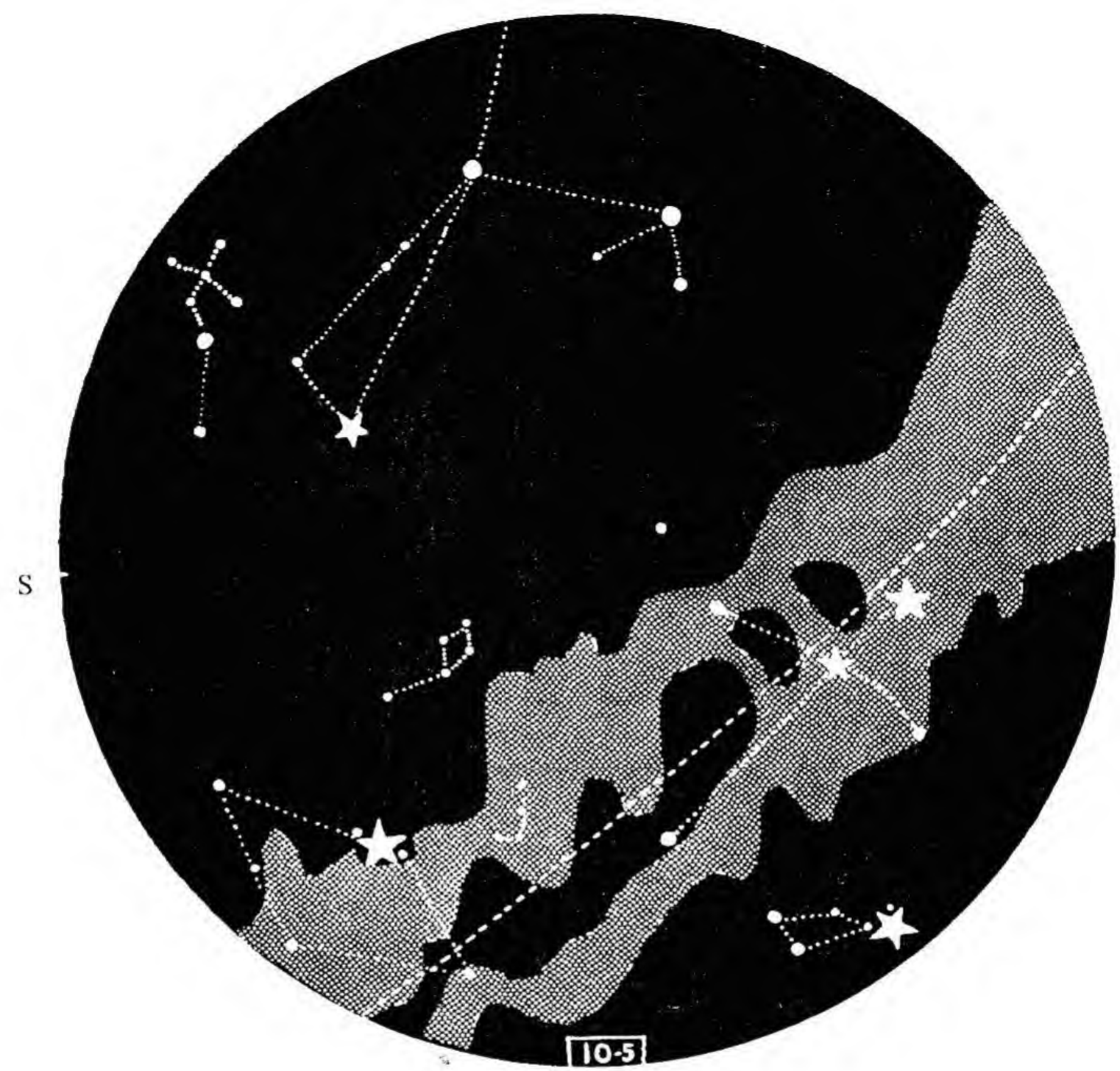
M 11 (NGC 6705) in Scutum beyond the line joining β and ε.

* * *

Two Comets*

Fig. 10.8 : The tail of the Great Comet of 1861 looked like a fan (right). One of the long tail naked eye Comet of 1843 (left).

* See *Comets* at page 233,



Observer's Latitude : 25° N

OCTOBER ZENITH NIGHT-SKY

June	1 at 5 a. m. (I. S. T.)	June	15 at 4 a. m. (I. S. T.)
July	1 at 3 a. m.	July	15 at 2 a. m.
September	1 at 11 p. m.	September	15 at 10 p. m.
October	**1 at 9 p. m.**	**October**	**15 at 8 p. m.**
November	1 at 7 p. m.	November	15 at 6 p. m.

Radio Telescope

TELESCOPES, IN common use and even those in famous observatories, are based on the optical properties of lenses and mirrors. With such a telescope, one can observe only objects as give out visible radiation of electro-magnetic waves of wave-lengths between 3000 (violet) and 8000 (red) Aengstrom units. These optical telescopes are practically ruled out for observations of stellar objects on account of the intervening opaque regions, consisting of dark nebulae, which obscure much of our view of the Milky Way.

Radio Telescopes have their origin in the work of an American enthusiast by name Jansky, in 1932. He discovered that the galaxy emitted radio waves of a wave-length of a few meters and that such sources of radiation can be located only by means of radio receivers, properly adapted for the purpose. A systematic survey of such radio sources came to be initiated and many were found out. It must be realised, here, that these sources of radiation would not have ever been detected even by the most powerful optical telescopes.

There is another advantage. While the work of the conventional telescopes is restricted to clear and perfectly moonless and cloudless nights, the radio telescopes are effective in cloudy conditions and even by day.

The radiation coming from a distant object is reflected from a large parabolic mirror to an aerial, situated at the focus, from which the signals are led to a radio receiver for detcction, amplification and record.

The resolving power of a telescope is a common term in Physics. It means the angular distance between two sources which the telescope can just distinguish as separate or as individual points. This basic definition of Resolving Power of a telescope applies to both kinds of telescopes, optical as well as radio. The desired resolving power is secured by making the aperture (which collects the incoming radiation) as large as possible and choosing the wave-length of the incoming radiation as small as possible. In optical telescopes the size of the mirror or the lens obviously determines the aperture, and the nature of the visible light determines the wave-length of the incoming radiation. In optical telescopes, therefore, there is not much choice.

The wave-lengths of radio waves are large as compared to those of light. Therefore, even by making the aperture as large as, say, 6 Kms in diameter, the radio telescope will have a very small resolving power. But with the other advantages of being able to see beyond dark clouds continuously by day and by night, radio-telescopes come to be preferred for certain types of astronomical work. Using the principle of interferometry, considerably higher resolving power can be obtained in radio telescopes.

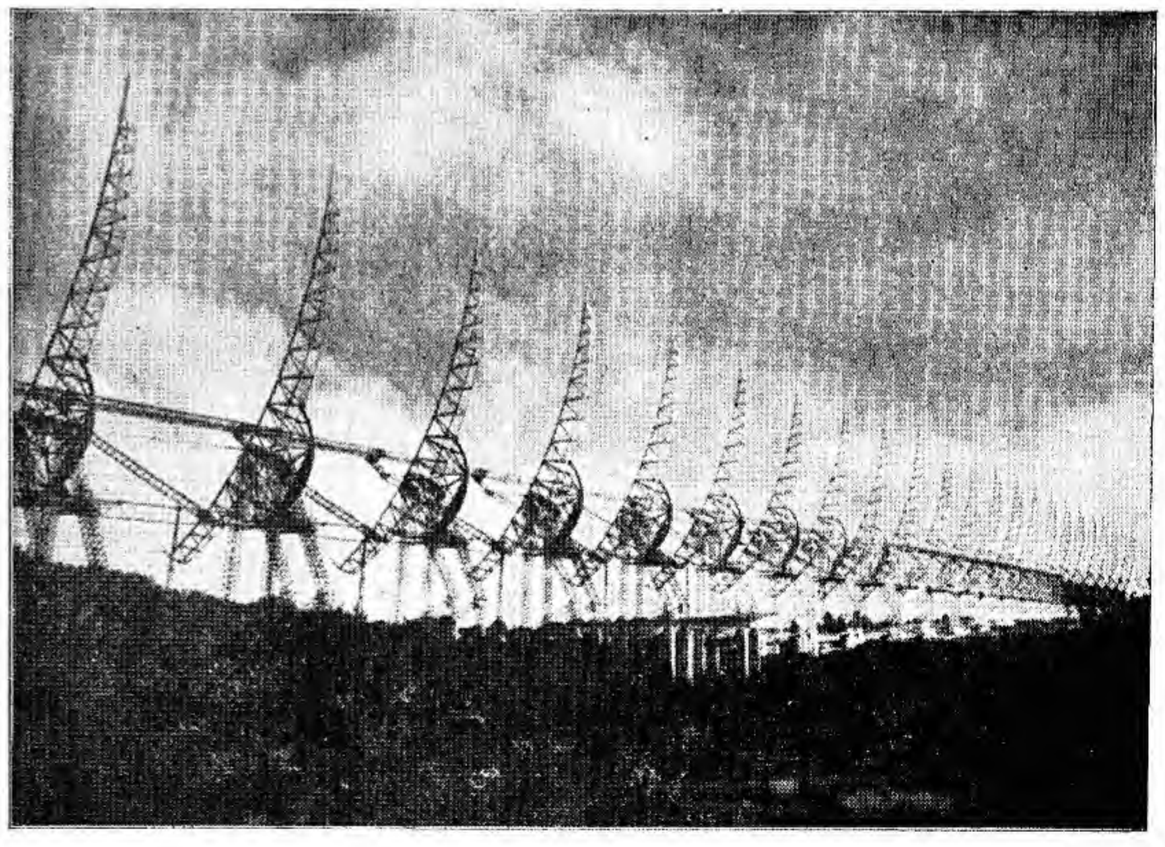
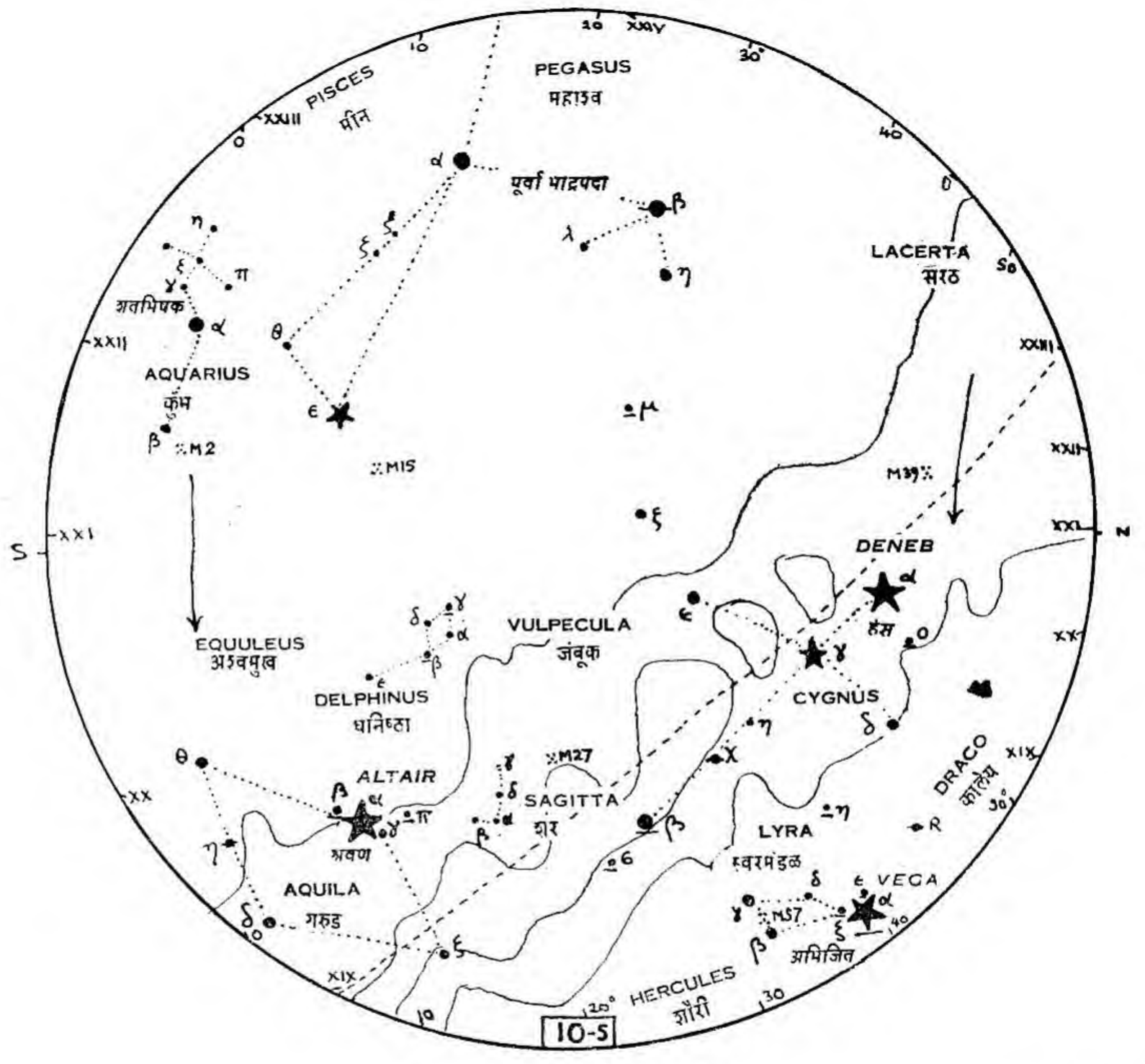


Fig. 10.9 : Radio Telescope at Ootaccamund

(Continued on Page 205 Column 2)



Observer's Latitude 25° N

OCTOBER ZENITH KEY-MAP

June	1 at 5 a. m. (I. S. T.)	June	15 at 4 a. m. (I. S. T.)
July	1 at 3 a. m.	July	15 at 2 p. m.
September	1 at 11 p. m.	September	15 at 10 p. m.
October	**1 at 9 p. m.**	**October**	**15 at 8 p. m.**
November	1 at 7 p. m.	November	15 at 6 p. m.

The Radio Sky

WITH THE help of Radio Telescopes*, astronomers have been able to study the structure of the Milky Way among other things. The clouds of hydrogen, that are abundant in the interstellar space, emit radio waves of wave-lengths centred at 21.1 cm. Several strong sources of radiation have been discovered by means of extensive surveys of the sky.

In the visible part of the Universe, it is estimated that there are more than 100,000 million galaxies like the Milky Way. Almost all galaxies radiate radio-waves, but some rare ones are extremely strong radio sources with a radio strength of million times the average. These are called 'radio galaxies' or 'radio sources' in general. One cause of the emission of radio waves from the galaxies appears to be very fast electrons with relativistic velocities moving in spiral paths in existing magnetic fields. It is suggested that radiation is produced when the single electron orbiting round the nucleus, in a hydrogen atom, changes its spin. (If the electron-spin changes, radiation of wave-length 21.1 cm is transmitted. The radiation is comparable to an emission line in the spectrum of visible light). This change of spin happens in each hydrogen atom on an average of once in 11 million years. Radio astronomers have worked out ingenious methods for observing this slight irregularity of intensity against the great intensity of the surrounding wave-lengths and the inherent noise of the receiver. The profile of this signal varies considerably with the direction along which we examine the Milky Way. Thus, it has been possible to plot certain 'hydrogen clouds' and the 'survey map' obtained has given us first idea of the spiral arms of the Milky Way.

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* See *Radio Telescope* at page 211

Over 2000 radio sources in the sky have been detected. More than 50 of the radio sources are double or complex systems with two or more distinct areas of radio-emissions, lying on each side of the galaxy visible though an opitcal telescope. A few of these sources are :-

Name of source	*Identified with*
Andromeda	M 31
Perseus	NGC 1275 : two colliding galaxies
Taurus A	Crab nebula M 1
Puppis A	Galactic nebulosity
Virgo A	Peculiar galaxy M 87
Centaurus A	NGC 5128 : probably two colliding galaxies.
Cygnus A	Two colliding spiral galaxies
Cassiopeia	Galactic nebulosity

Optical methods, however powerful, would never have led us to this kind of survey of the sky. Visible and infra-red radiations are absorbed by the intervening clouds of dust and thus they cannot possibly reach the Earth. Only the radio-radiation at 21 cm can get through and it has been possible to explore the large and the small Magellanic Clouds.** in this manner.

Principle of radar can also be applied to radio-telescopes. Radio-telescope emits a directional signal, which is reflected by a celestial object and then received again by the radio-telescope.

Applications are many. In planetary research, the wave-lengthts used range from 1 cm to 15 metres. Temperatures of most planets have been determined in this way. Jupiter is discovered to possess an ionosphere and a magnetic field.

* * *

** See *Magellanic Clouds* at page. 113.

Observer's Latitude : 25° N

NOVEMBER
NORTH
NIGHT-SKY

July	1	at	5	a. m. (I. S. T.)	July	15	at	4	a. m. (I. S. T.)
August	1	at	3	a. m.	August	15	at	2	a. m.
October	1	at	11	p. m.	October	15	at	10	p. m.
November	**1**	**at**	**9**	**p. m.**	**November**	**15**	**at**	**8**	**p. m.**
December	1	at	7	p. m.	December	15	at	6	p. m.

Cassiopeia

FACING NORTH, at 8 p.m. in the middle of November we see the broad white belt of the Milky Way stretched across the sky. On the left-hand side, we notice the bright star Altair (α of Aquila), Deneb (α of Cygnus). On the right, we see Capella (α of Auriga) and Aldebaran (α of Taurus). Cassiopeia is almost exactly above the Pole Star and situated in the Milky Way. Five bright stars of this constellation make the letter M of the English alphabet. Some imagine the figure of Cassiopeia in an inverted long chair. Owing to its peculiar shape the constellation is easily located.

In ancient mythology, Cassiopeia was an Ethiopean Queen. She was beautiful and very proud. She wished that all others should be envious of her charms. Cassiopeia showed her utter disregard and contempt to the sea-nymphs and to prove this she placed her throne on the shore. When she was placed among the constellations a strong protest came to be lodged to Jupiter. As a result of this general discontent, Gods ordered that Cassiopeia's chair would always appear in the sky in a tilted fashion. It is actually seen like this most of the time. This strange humiliation was slightly mollified afterwards by naming the two prominent stars α and β in the constellation as 'Shedar' and 'Caph,' which, in Arabic, mean the 'Heart' and the 'Tinted Hand,' respectively, presumably of the Queen.

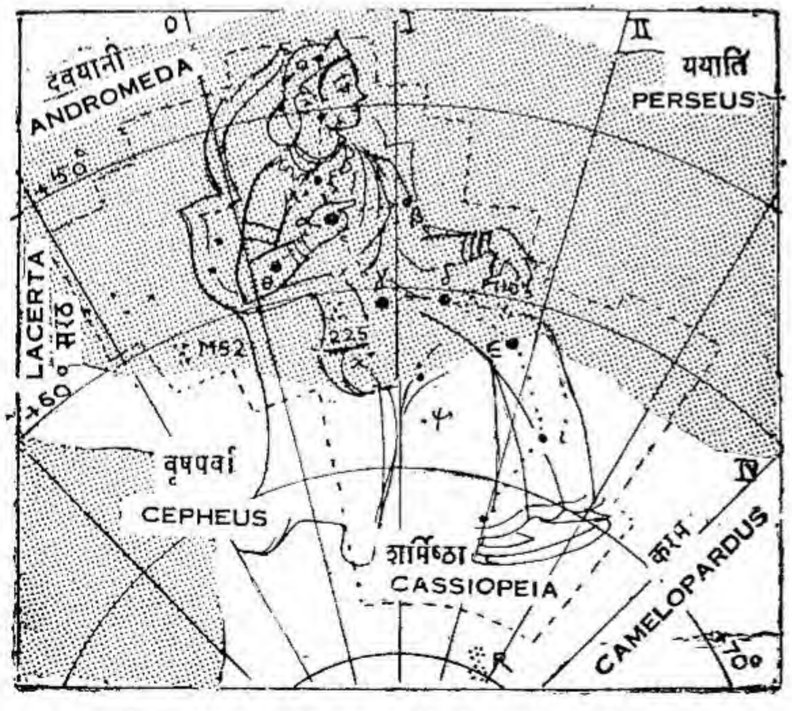

Fig. 11.1 : Cassiopeia (Sarmiṣṭhā)

Cassiopeia in Indian astronomy is called *Śarmiṣṭhā* (शर्मिष्ठा) According to mythology, this was the beautiful daughter of King *Vṛṣaparvā* (वृषपर्वा), son of sage *Kāśyapa* (काश्यप). She had a devoted friend by name *Devayānī* (देवयानी),** who was the daughter of another sage *Śukrācārya* (शुक्राचार्य), famous for his extra-ordinary power of being able to revive the lives of dead persons. This power is described as *Sanjīvanī* (संजीवनी). Once upon a time, the two girls were bathing in a river and had kept their clothes under a tree on the bank. In the meanwhile a strong wind developed, which blew away the clothes and got them mixed up. The girls did not notice the mix-up until they were ready to return home. *Śarmiṣṭhā*, being the daughter of a king, felt offended that her dress was worn by *Devayānī* who was merely the daughter of a priest, In her anger, *Śarmiṣṭhā* threw *Devayānī* in a well and returned home alone.

Cassiopeia and Ursa Major make a 'celestial clock' and. with sufficient practice and accurte knowledge of local longitude, it is possible to estimate time fairly accurately. When β (Caph) of Cassiopeia is above the Pole Star, Hour-Angle O coincides with Local Meridiam. When, α, β (Pointers) of Ursa Major are above the Pole Star, as in the month of May, Hour-Angle XI coincides with the Local Meridian.

Star α, known as Shedar, is a lovely double, seen with naked eyes, and also a variable with a period of about 40 days. The star α is called Sih and the star δ is called Ruehbak. Star β is callcd Caph.

A beutiful Nova had appeared in this constellation in the year 1572 A. D. and it was, for some time, as bright as Venus and it is reported that it could be seen even in broad daylight.

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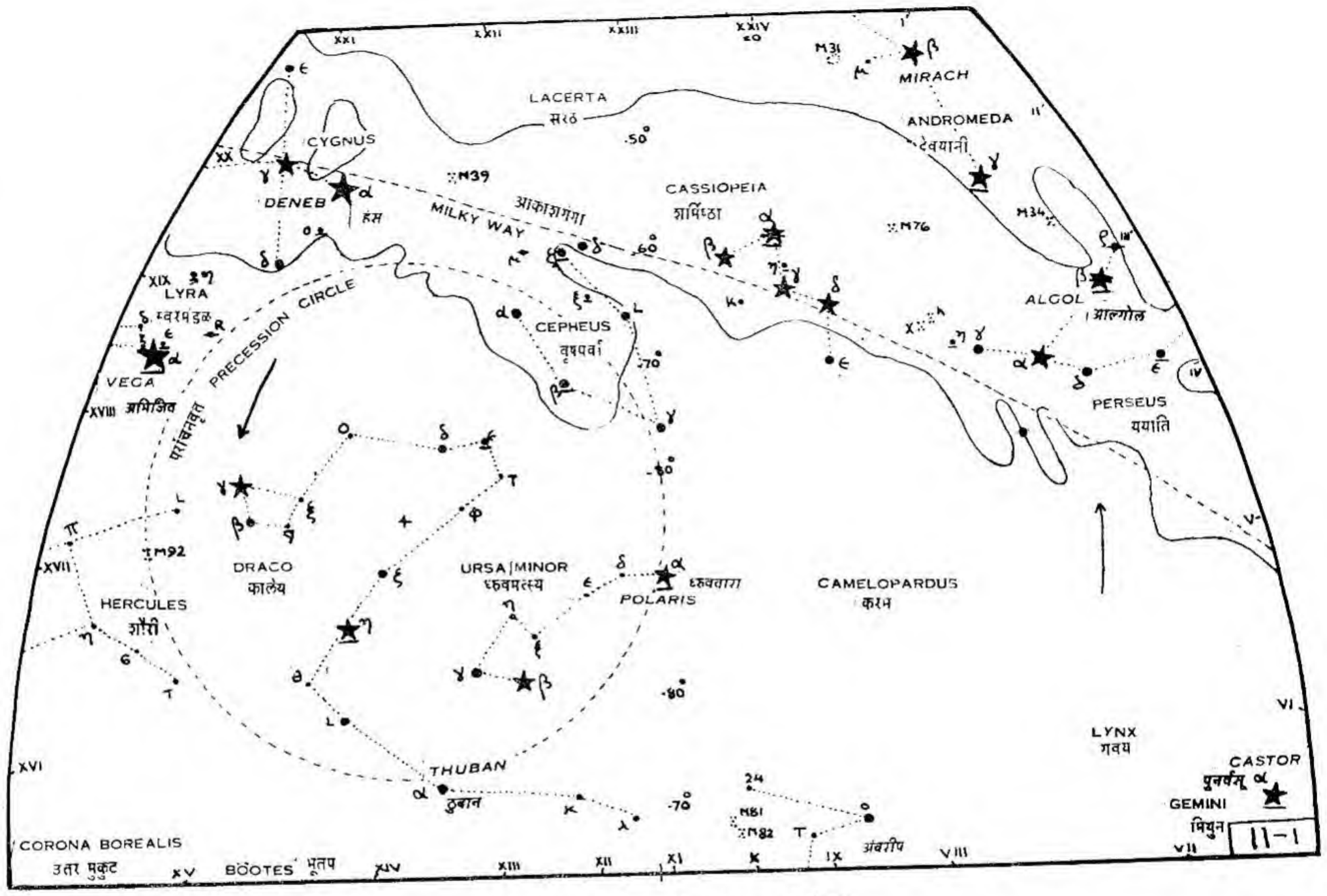
* See *Cepheus* at page 15

** See *Andromeda* (*for Devayānī*) at page 219

* * *



Observer's Latitude : 25° N

NOVEMBER
NORTH
KEY - MAP

July	1 at	5 a. m. (I. S. T.)	July	15 at	4 a. m. (I. S. T.)
August	1 at	3 a. m.	August	15 at	2 a. m.
October	1 at	11 p. m.	October	15 at	10 p. m.
November	**1 at**	**9 p. m.**	**November**	**15 at**	**8 p. m.**
December	1 at	7 p. m.	December	15 at	6 p. m.

NOVEMBER : NORTHERN SKY

Prominent Stars :

β, γ in Andromeda (Mirach, Almach).
α, β (Shedar and Caph) and 3 other stars in Cassiopeia forming the English letter W or M.
α, β in Cygnus (Deneb and Alberio).
α in Draco (Thuban), former Pole Star.
α in Gemini (Castor).
α in Lyra (Vega), future Pole Star.
β in Perseus (Algol).
α in Ursa Minor (Polaris); present Pole Star.

Double Stars :

γ in Andromeda, gold and blue, seen with a small telescope.
η in Cassiopeia, orbital period 526 years, seen with a 5 cm telescope.
β, ξ in Cepheus, seen with a 5 cm telescope. β is a spectroscopic binary.
β, μ, o_2 in Cygnus, seen with a field-glass.
o_2 in Cygnus is really a triplet,
ν in Draco, equally bright pair, seen with a binocular.
ε n Lyra, wide double 200″ apart, seen with naked eyes.
ζ, β in Lyra, wide pairs for binoculars.
β in Perseus, an eclipsing binary, known since 300 years ago. It has 2 more components making it a quadruple.
α in Ursa Minor, wide double, seen with a 5 cm. telescope.

Variable Stars :

δ in Cepheus, typical short period variable.
χ in Cygnus, Mira type and varies through 10 magnitudes.
β in Persues, regularly variable of period 2 d. 20 hrs. 48.9 min.

Nebulae and Star Clusters :

M 31 (NGC 224) in Andromeda, near ν, oval and hazy, seen with naked eyes.
NGC 752 in Andromeda near γ. Large and open.
M 39 (NGC 7092) in Cygnus beyond α, near π^2, open cluster and seen with field glasses.
Cygnus contains a strong source of radio emission.
h (NGC 869) and χ (NGC 884) in Persues, bright diffuse spots, seen with naked eyes.

* * *

Planetarium

THE PLANETARIUM was originally a device to illustrate the motions of the Planets round the Sun. The present day Planetarium, that one sees nowadays in big towns, is a very powerful instructor. It mainly consists of a complicated optical projector which simulates, on the inside of a large dome, the apparent movements of the Sun, Moon and planets against the background of the constellations in the night-sky, also projected on the dome. The diurnal motion is illustrated at an accelerated tempo. The Sun rises and sets. We see the moon crossing the sky in her various phases. The plenets follow their elliptical orbits. The accelerated speed, at which the projection takes place, gives an excellent idea of the various celestial phenomena illustrated on the dome.

Using this idea of representing the celestial bodies and their movements by projection, it is now possible for laymen to conceptualize and at the same time visualize the fantastic effects of space travel, observe innumerable distant stellar objects from the earth and from different points in space. The night-sky studded with stars can be reproduced in its original form from any point of the surface of the earth and simultaneously at any desired point of time.

There are several Planetaria installed in India, The latest is the Nehru Planetarium installed in Bombay in 1977

* * *

Observer's Latitude : 25°N

NOVEMBER EAST NIGHT-SKY

July	1 at 5 a. m. (I. S. T.)	15 at 4 a. m. (I. S. T.)
August	1 at 3 a. m.	15 at 2 a. m.
October	1 at 11 p. m.	15 at 10 p. m.
November	**1 at 9 p. m.**	**15 at 8 p. m.**
December	1 at 7 p. m.	15 at 6 p. m.

Andromeda

IN THE north-east corner of the night-sky at 8. p.m. in the month of November, Andromeda can be seen well above the horizon. The bright star Capella (α in Auriga) is near the horizon on the left and in the Milky Way. Above it is Algol (β in Perseus) and above it, at almost the same height, is Andromeda. The famous Andromeda Nebula can be located almost halfway between Algol and Alpheratz (α of Andromeda), which makes the square of the constellation Pegasus.

In Greek Mythology, Andromeda is metioned as the daughter of King Cepheus. She was chained to the rocks and left at the mercy of the sea monsters, on the advice of an oracle, to pacify the Nereids. The Nereids were sea nymphs who very much resented the vanity of Cassiopeia*, the mother of Andromeda and the beautiful but arrogant queen of Cepheus. According to the legend, a warrior by name Perseus** rescued Andromeda from the sea monsters and married her afterwards. Subsequently Andromeda came to be placed among the constellations.

The Indian version of the legend is somewhat similar, but the incidents are different. Instead of (1) Cepheus the King, (2) Cassiopeia the Queen, (3) Andromeda the daughter and (4) Perseus the warrior, Indian counterparts are (1) *Vrasparva* (वृषपर्वा) the King and son of the sage *Kaśyapa* (काश्यप), (2) His daughter is *Śarmiṣṭha* (शर्मिष्ठा), (3) *Devāyanī* (देवयानी) is the daughter of sage *Śukrācārya* (शुक्राचार्य), who possessed the super-natural power of reviving the dead and (4) *Yayati* (ययाति) was the warrior to rescue *Devayani.*

Devayāni and *Śarmiṣṭha* were great friends but on one occasion they had disagreement owing to a mix-up of clothes after a river bathing. *Śarmiṣṭhā* the princess threw *Devayāni*, who was merely a priest's daughter, into a well and returned home alone. *Yayāti* was a prince from the neighbourhood. While hunting he chanced to pass the well and feeling thirsty looked into it and saw *Devayānī*. *Yayāti* got her out of the well and later asked her to marry him. *Devayani* agreed to do so on condition that *Śarmiṣṭhā*, who had insulted her previously, became her maid servant.

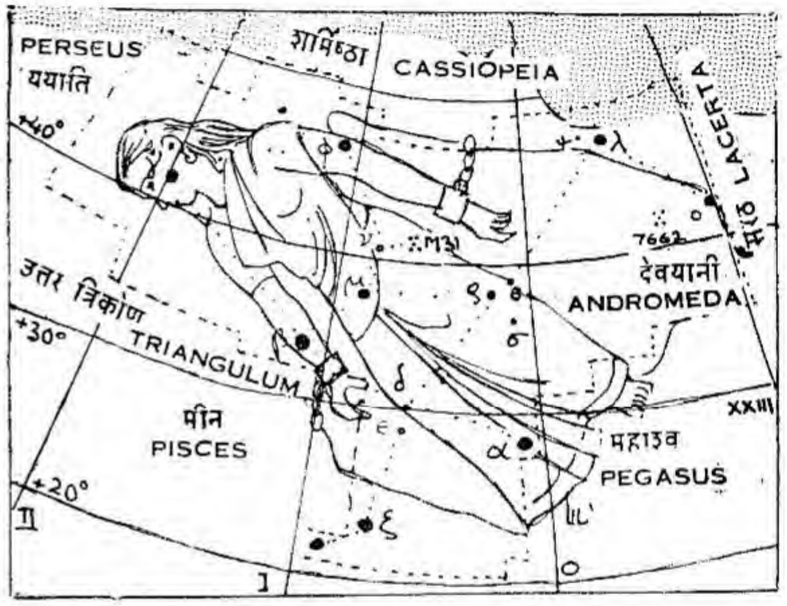


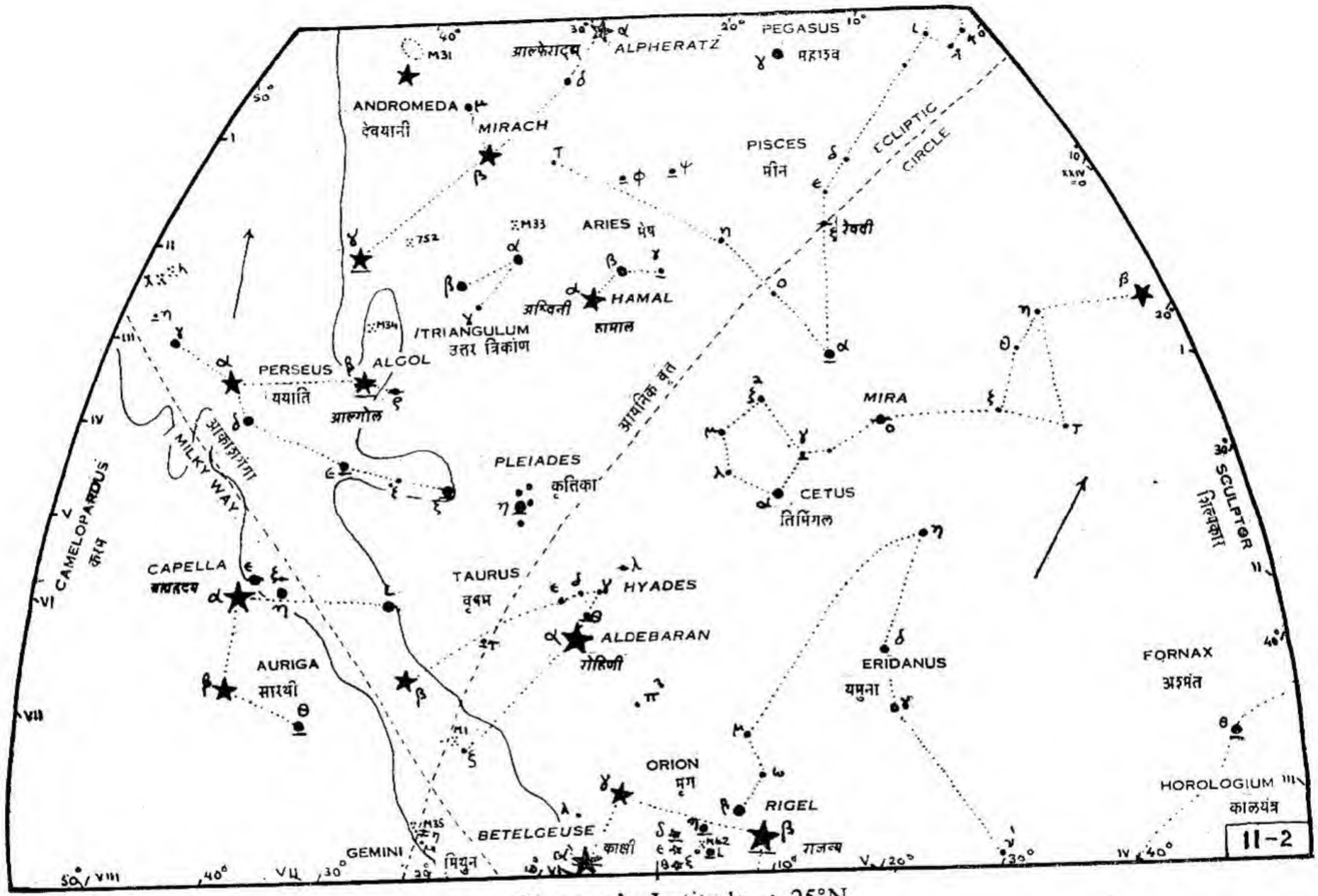
Fig. 11.2 : Andromeda (Devayāni)

Nebula known as M 31 (NGC 234) is the most beautiful sight in this constellation and it can be seen with naked eyes. Starting from the bright star α of Perseus and proceeding towards the square of Pegasus, we meet the three bright stars of Andromeda, in this order; first α (Almach), then β (Mirach) and finally α (Alpheratz). Formerly this last star used to be regarded as part of Pegasus, making the square Completc. Nowadays, Alpheratz is not included in Pegasus.

Andromeda nebula is above the star β (Mirach) in the north-western direction. The nebula appears as an oval shaped diffuse spot about 30′ long and 15′ broad. It was discovered by the French

(Continued on page 221 column 2

* See *Cassiopeia* at page 215
* See *Perseus* at page 235



Observer's Latitude : 25°N

NOVEMBER
EAST
KEY-MAP

July	1 at 5 a. m. (I. S. T.)	July	15 at 4 a. m. (I. S. T.)
August	1 at 3 a. m.	August	15 at 2 a. m.
October	1 at 11 p. m.	October	15 at 10 p. m.
November	**1 at 9 p. m.**	**November**	**15 at 8 p. m.**
December	1 at 7 p. m.	December	15 at 6 p. m.

NOVEMBER : EASTERN SKY

Prominent Stars :

α, β, γ in Andromeda (Alpheratz, Mirach, Almach).
α in Aries (Hamal).
α in Auriga (Cepella).
α, β, o in Cetus (Menka, Diphda, Mira),
ω, β in Orion (Betelgeuse and Rigel).
β in Perseus (Algol).
α in Taurus-Hyades (Aldebaran).
η in Taurus-Pleiades, (Alcyone).

Double Stars :

γ in Andromeda, gold and blue object seen with a small telescope.
Ψ, ξ in Pisces, easily resolvable doubles.
β in Perseus (Algol), famous eclipsing binary, oldest known. It has 2 more components making it a quadruple.
ε, ζ, η in Perseus, seen with a 5 cm. telescope. η is yellow and its companion blue.
η in Taurus, bright wide double, 20-30 stars can be seen with a field-glass
θ in Taurus-Hyades, wide and naked eye double.
τ in Taurus-Hyades, seen with a field-glass.

Variable Stars :

o in Cetus, typical long period variable with a period of 332 days. Variation from 1.7 to 9.6 magnitudes, roughly through a factor of 2100.
α in Orion is an irregular variable.
β in Perseus (Algol), regular variable, eclipsing type.

Nebulae and Star Clusters :

NGC 752 in Andromeda near γ, large and open.
M 31 (NGC 224) in Andromeda near ν, hazy spot seen with naked eyes. Extra-galactic and receding.
h (NGC 869) and χ (NGC 889) in Perseus, beautiful bright and diffuse spots.
M 76 in Perseus near φ. Dumb-bell shaped, belonging to our galaxy. A faint nebula in Pleiades, near ' Merope', near St. 23, (not shown here) seen through the view-finder of a telescope.

* * *

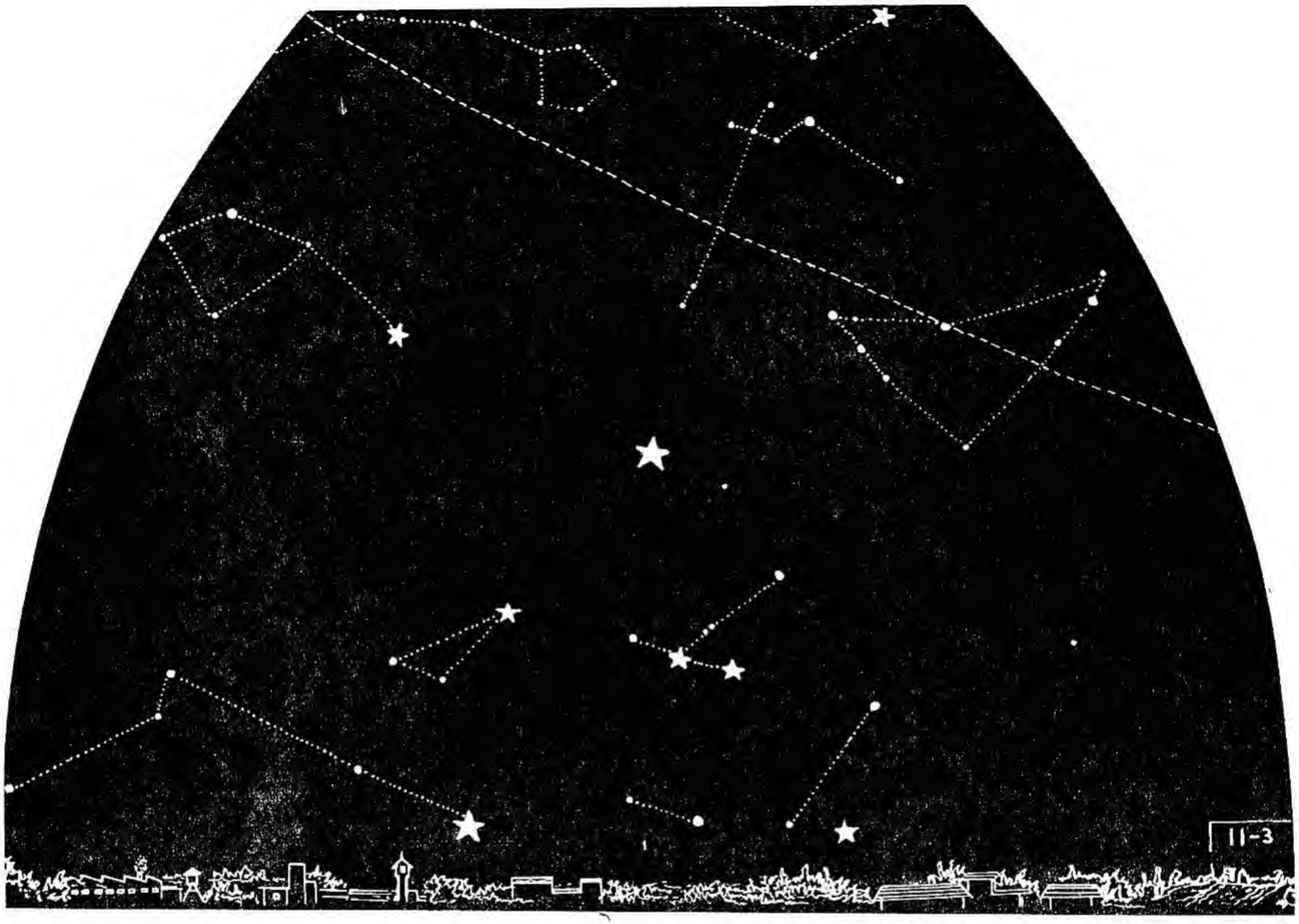
(Continued from page 219 column 2)

Andromeda

astronomer Messier in 1612. A. D. Arab astronomers are reported to have noticed this nebula earlier and with naked eyes. According to present knowledge, Andromeda nebula is an indepedent galaxy, about 2,200,000 light-years away from us and it has a diameter of about 2 000,000 light-years. The nebula is of the spiral type and it is approaching us with a velocity of 300Km. per second. It contains about 2×10^{14} stars, more than 100 Novae and the total mass of the galaxy is estimated to be equal to 3×10^{11} solar masses. Seen through a telescope, one can get a general idea of the shape of a galaxy and infer from it the shape of our galaxy, the Milky Way.

Star α (Alpheratz) is a double, seen through a small telescope with gold and blue partners.
Star β is called Mirach.
Star γ (Almach) is a triplet, with orange, emerald and blue partners.

* * *



Observer's Latitude : 25°N

NOVEMBER SOUTH NIGHT-SKY

July	1 at	5 a. m. (I. S. T.)	July	15 at	4 a. m. (I. S. T.)
August	1 at	3 a. m.	August	15 at	2 a. m.
October	1 at	11 p. m.	October	15 at	10 p. m.
November	**1 at**	**9 p. m.**	**November**	**15 at**	**8 p. m.**
December	1 at	7 p. m.	December	15 at	6 p. m.

Pisces

THE CONSTELLATION, meaning the Fish, is conspicuous, and at the present time, it coincides with the Vernal Equinox. Being in the Ecliptic belt it is one of the Zodiacel Signs and according to Indian nomenclature, it is called the *Mīna Rāśī*) (मीन राशी)

On the southern side of Pegasus, below the line joining γ (Algenib) and α (Markab) of that constellation lies a group of stars which, when connected, make up a polygon with seven sides. This is the head of the Fish. On the left hand side α represents the tail of the fish. The other fish has its head below Triangulum and Andromeda and it resembles a kite flown high up with a string starting from star α. This star α in Pisces is called Kaitaim.

According to a Greek legend, the giant Typhon made his appearance on land and frightened even the Gods who fled away to the river Nile and hid themselves under assumed shapes. Jupiter changed himself into

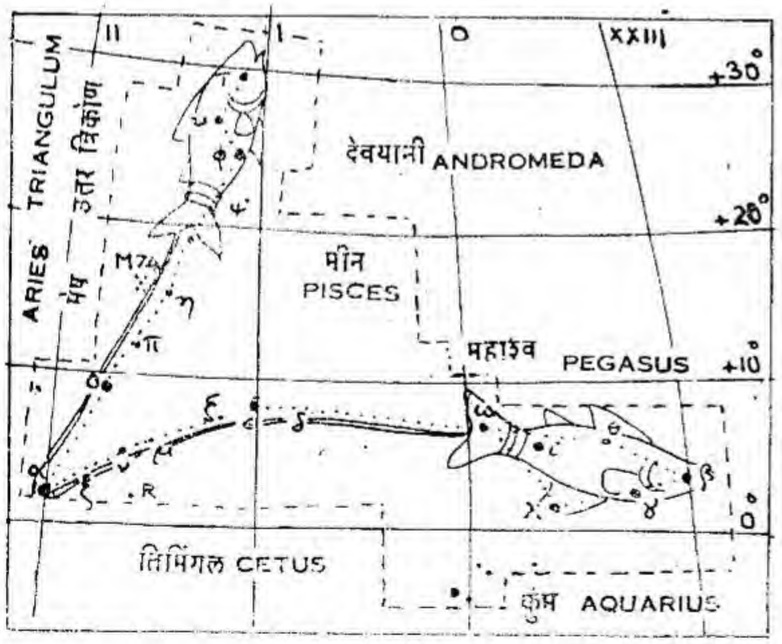


Fig. 11.3 : Pisces (Matsya)

a Ram (Aries) and Pan took the shape of a Sea-Goat (Capricornus), Goddess Venus and her son Cupid threw themselves into the river and changed themselves into two Fishes. The two tied-up fishes, thus, represent the constellation Pisces.

In the extensive constellation Pisces, a small group of 32 stars is designated as *Revatī* (रेवती) in Indian astronomy. The star ζ of Pisces is regarded as its principal star. It is called *Jayantī* (जयंती). *Zeta Piscium* is near hour-angle I and about 8° below the continuation of the line joining α and γ of Pegasus by the same length.

* * *

Phoenix

THE NAME of the constellation is modern. The constellation is situated in the Southern Hemisphere and lies between Sculptor and Eridanus. Stars of 3rd and 4th magnitude make up the figure of a rhombus. (See Fig. 11.4).

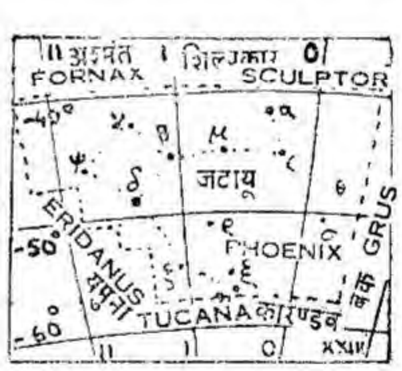


Fig. 11.4 : Phoenix

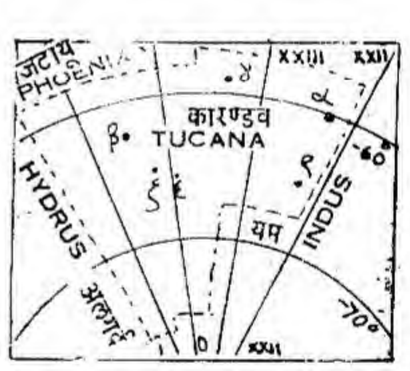
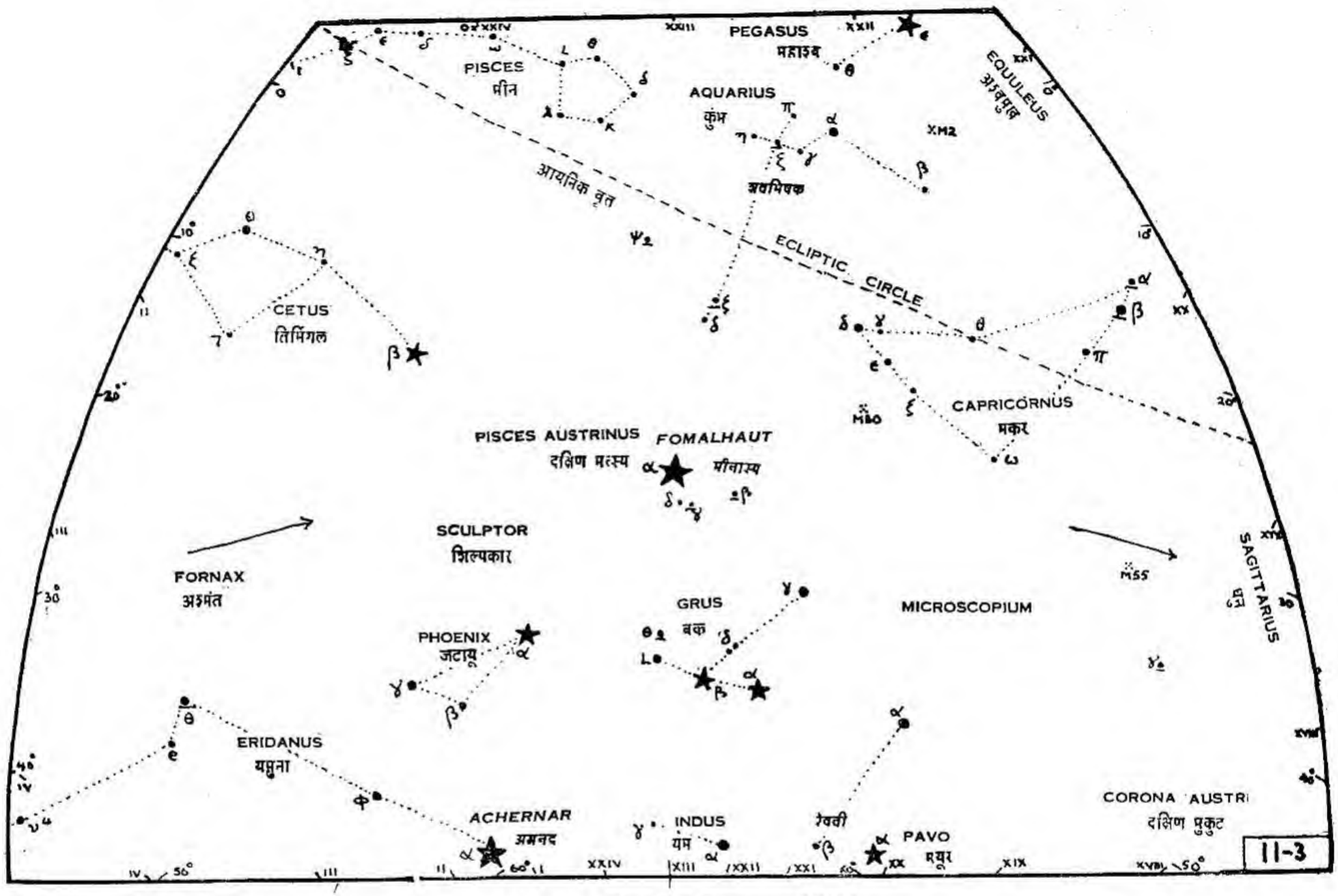


Fig. 11.5 : Tucana

Tucana

THIS CONSTELLATION mostly remains invisible to us, being situated in the Southern Hemisphere and lying between −57°S 4.5. and 75°S Declination. The name Tucana is that of a bird known as Tucan. β is a double star and is a superb object being of magnitude 4.5. It is found at −72°S. There is globular cluster which should be just visible to the naked eyes. (See Fig. 11.5). * * *



Observer's Latitude : 25°N

NOVEMBER SOUTH KEY-MAP

July	1 at 5 a. m. (I. S. T.)	July	15 at 4 a. m. (I. S. T.)
August	1 at 3 a. m.	August	15 at 2 a. m.
October	1 at 11 p. m.	October	15 at 10 p. m.
November	**1 at 9 p. m.**	**November**	**15 at 8 p. m.**
December	1 at 7 p. m.	December	15 at 6 p. m.

NOVEMBER : SOUTHERN SKY

Prominent Stars :

α in Pisces Austrinus (Fomalhaut).
α in Capricornus (Giedi).
β in Cetus (Diphda).
α in Eridanus (Achernar).
α, β in Grus.
α in Pavo.
α in Phoenix.

Double Stars :

ψ_1 in Aquarius, nice double, seen with a field-glass.
ζ in Aquarius, an object for a 7.5 or 10 cm. telescope.
ψ_1, ζ in Pisces, easily resolvable doubles.
α, ϕ in Pisces, seen only with a large telescope.

Variable Stars :

o in Cetus, first discovered variable, period 332 days, changes through 1.7 to 9.6 magnitudes, equivalent to a change in brightness by a factor of 2100.
β in Pegasus, variation from 2.2 to 2.7 magnitudes.

Nebulae and Star Clusters :

M 2 (NGC 7089) in Aquarius near β, Visible to naked eyes.
M 30 (NGC 7099) in Caricornus, near ζ, Seen with a field-glass.
M 15 (NGC 7078) in Pegasus, near ε, globular and brilliant.

* *

Rings of Saturn and of Uranus

SATURN (left) has four rings around the central globe. Its fourth ring was discovered in 1971. Uranus (right) has five rings and all of them were discovered in 1977. The rings of Saturn are quite close to it. According to some authorities the innermost crepe-like ring extends right upto the globe of Saturn. The outer three rings are very bright. The rings of Uranus, on the other hand, are quite narrow and much further away from it, but, of course, are within Roche limit. They are extremely faint and were actually discovered by absorption of light of a distant star seen through them from above the Earth's dense atmosphere. In this figure, which is an artist's conception, they are purposely shown to be as bright as those of Saturn. Of these five rings, the outermost is relatively much brighter. For the sake of comparison, the globes of both Saturn and Uranus are shown here to be of the same size.

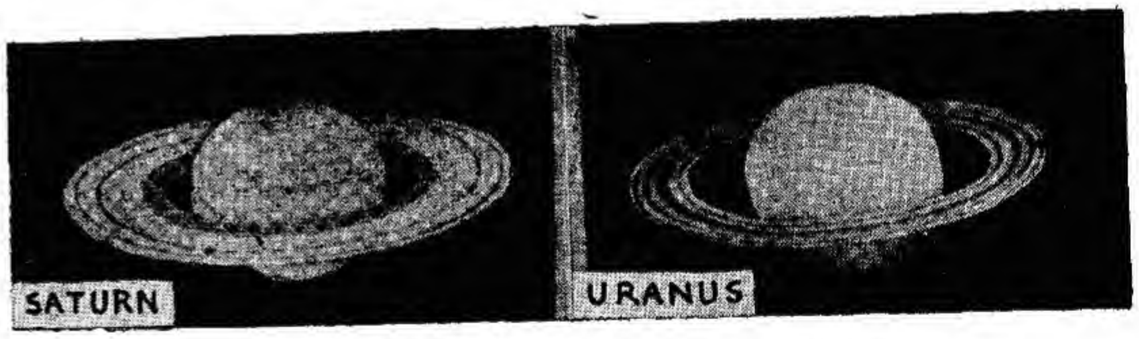
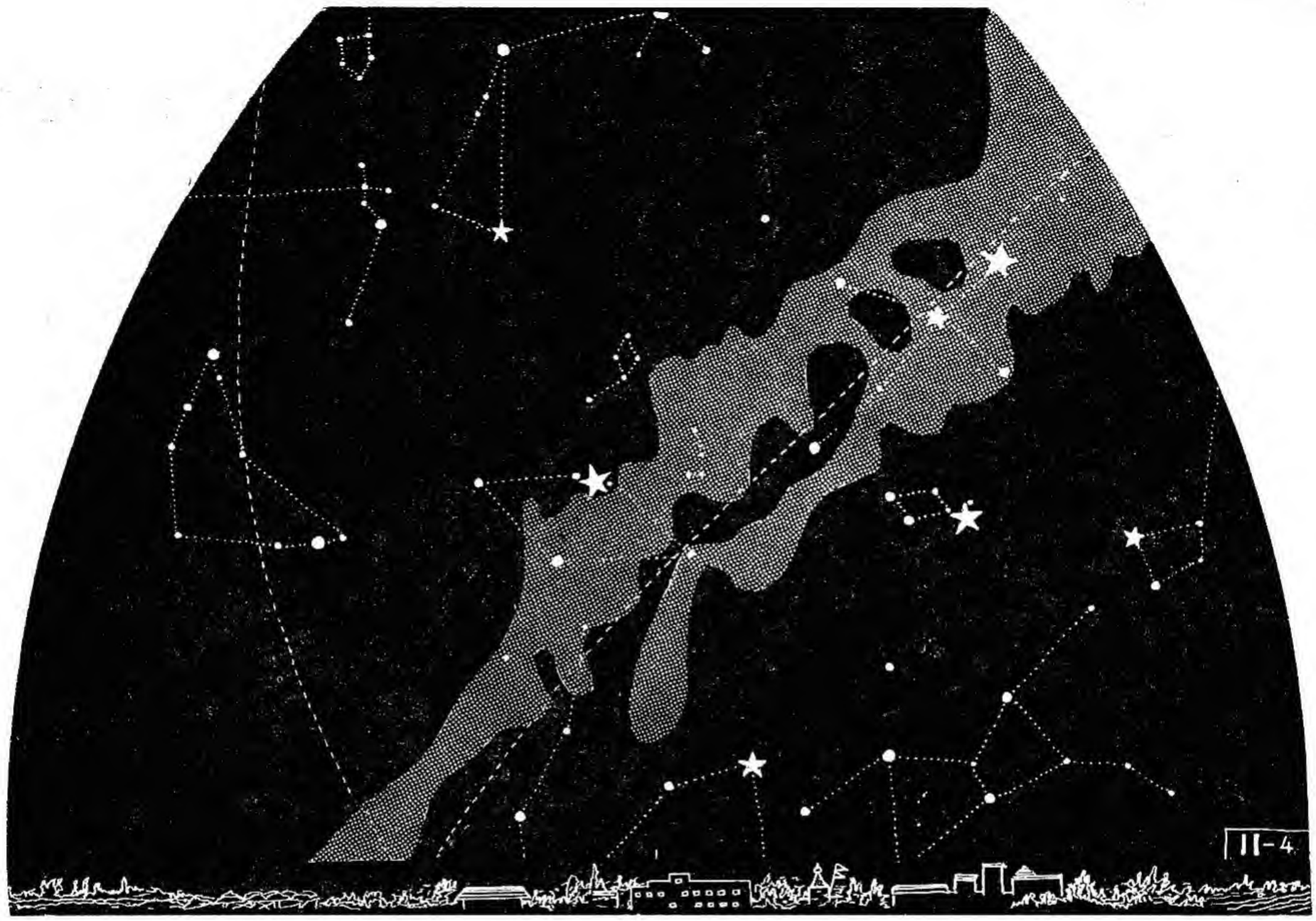


Fig. 11.6 : Rings of Saturn and Uranus
(From an Artist's drawing.

* * *



Observer's Latitude : 25° N

NOVEMBER WEST NIGHT-SKY

July	1 at 5 a. m. (I. S. E.)	July	15 at 4 a. m. (I. S. T.)
August	1 at 3 a. m.	August	15 at 2 a. m.
October	1 at 11 p. m.	October	15 at 10 p. m.
November	**1 at 9 p. m.**	**November**	**15 at 8 p. m.**
December	1 at 7 p. m.	December	15 at 6 p. m.

Pisces Austrinus

THIS IS a constellation of the Southern Hemisphere and it is for that reason known as Pisces Austrinus. This constellation is situated beneath Aquarius. The nomenclature is modern. Its former name was Pisces Australis. The location of the constellation is such that a stream of water, or nectar, from the water-bearer Aquarius* neatly falls into the mouth of the Southern Fish.

The Southern Fish must not be confused with the picture of the two tied fishes of the constellation Pisces, known otherwise as the Northern Fish. The entire region of the sky, in this section, is called the Sky Sea. The reason for this nomenclature is apparent. It contains the three fishes, (two in Pisces and one in Pisces Austrinus), Cetus** (the Whale), Delphinus *** (the Dolphin), and Capricornus **** (the Sea-Goat).

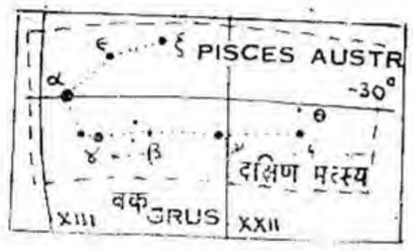


Fig. 11.7 : Pisces Austrinus

The principal star α is known as Fomalhaut, which in Arabic means ' the Mouth of a Fish '. This star is very bright . of magnitude 1.3, and is on the same hour-angle XXIII as that of Markab (α of Pegasus). Fomalhaut is an important star in the south and it brings to mind the advent of the Autumn season as the other stars Spica, Antares and Sirius remind us of the Spring, Summer and Winter respectively.

In Persian literature, about the period 3000 B.C., Fomalhaut was one of the four stars, known as Royal Stars. At that time the sun used to be here in the Summer Solstice

* See *Aquarius* at page 203 ** See *Cetus* at page 27
*** See *Delphinus* at page 147 **** See *Capricornus* at page 179

* * *

Grus

THE CONSTELLATION is in the southern hemisphere. The nomenclature is modern and it means the Crane. It contains two bright stars α and β of magnitude 2 and the constellation is situated on the southern side of Pisces Austrinus. The main stars are about 120 and 230 light-years away from us. The other stars are faint and generally of magnitudes 4 and 5. The stars make up, according to some, the figure of a Cross*, but it must not be confused with Crux, the Southern Cross.

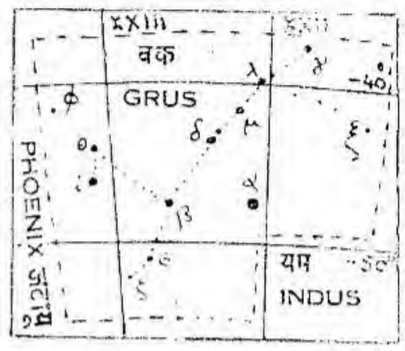


Fig. 11.8 : Grus

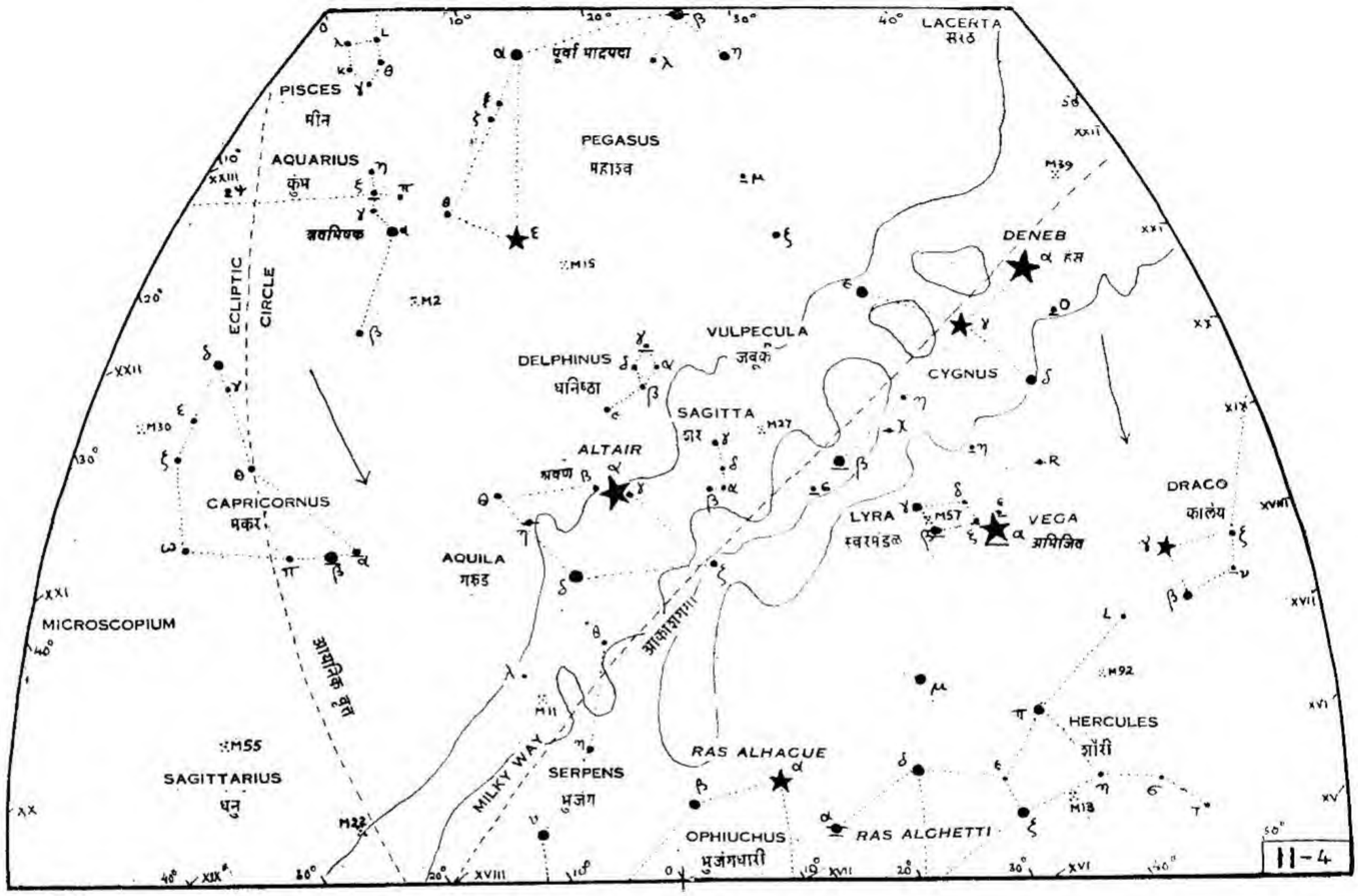
* * *

Pulsars

THE DISCOVERY of the Pulsars became possible during the investigation of Quasars** which are starlike radio sources and whose origin is still one of the outstanding problems of astro-physics. Pulsar is a Radio Star which emits succession of radio pulses as regularly as a time service. One of the earliest surprises was the discovery that each 'pulse' was associated with radio signals of continously changing wave-length. Measurement of the instantaneous band-width of the radiation showed that the actual duration of a 'Pulse'

(Continued on page 237, column 2)

*See *Crux* at page 103 ** See *Quasars* at page 239



Observer's Latitude : 25°N

NOVEMBER
WEST
KEY - MAP

July	1 at 5 a. m. (I. S. T.)	July	15 at 4 a. m. (I. S.T.)
August	1 at 3 a. m.	August	15 at 2 a. m.
October	1 at 11 p. m.	October	15 at 10 p. m.
November	**1 at 9 p. m.**	**November**	**15 at 8 p. m.**
December	1 at 7 p. m.	December	15 at 6 p. m.

NOVEMBER : WESTERN SKY

Prominent Stars :

α in Aquarius (Sad-al-Malik).
α in Aquila (Altair).
α in Capricornus (Giedi).
α, β in Cygnus (Deneb and Albireo).
α in Hercules (Ras al Ghetti).
α in Lyra (Vega).
α in Ophiuchus (Ras al Haque).
α, β in Pegasus (Markab, Sheat).

Double Stars :

ψ_1 in Aquarius, seen with a field-glass.
ζ in Aquarius, seen only with a 7.5 or 10 cm. telescope.
π in Aquila, test for a 7.5 cm. telescope.
γ in Delphinus, yellow and emerald, seen with a 5 cm. telescope.
Star 6 in Vulpecula, wide optical double 400″ apart, components of 4.5 and 5.7 magnitudes (not shown here).

Variable Stars :

η in Aquila, variable of the Cephied type, period 7.18 days.
β in Pegasus, variation from 2.2 to 2.7 magnitudes.

Nebulae and Star Clusters :

M 2 (NGC 7089) in Aquarius near β, seen with naked eyes.
M 30 (NGC 7099) in Capricornus near ζ, globular, seen with a field-glass.
M 39 (NGC 7092) in Cygnus and large open cluster and well seen with low power field-glass.
M 57 (NGC 6720) in Lyra, Ring Nebula, seen with a 15 cm. telescope.
M 15 (NGC 7978) in Pegasus near ε, globular and brilliant.
M 22 (NGC 6656) in Sagittarius, between μ and σ, a large bright globular cluster.
M 11 (NGC 6705) in Scutum. A grand fan-shaped cluster with bright star at apex.
M 27 (NGC 6853) in Vulpecula. Planetary Nebula. This nebula forms an equilateral triangle with stars 12 and 13, and is pointing towards star 29. Seen only with a large 25 cm. telescope.

* * *

The Moon

IN ITS daily passage through the sky, the Moon crosses the meridian later than the day before by about 51 minutes. This means that the Moon has an eastward motion superposed on the apparent daily motion of stars on the celestial sphere. The Moon has it own motion. Its orbit round the Earth is elliptical and it makes an angle of 5° with the ecliptic. The angular distance between the Sun and the Moon is called elongation. The Moon overtakes the Sun thirteen times a year, and whenever it does so it is called a conjunction.

The Moon always keeps the same side (face) turned towards the Earth on account of the simple fact that the Moon's rotation requires exactly the same time as required for its one revolution around the Earth. It is now possible to take photographs of the rear side of the Moon, from manned and unmanned rocket moon probes.

The time taken by the Moon, as viewed from the Earth, to complete one revolution on the celestial sphere — from one star back to the same star — is called the siderial month and it is on an average 27 days 7 hours 43 minutes and 11.47 seconds.

The Moon has been regarded as a satellite of the Earth. This view, however, needs revision. The Moon's mass, 1/81 of that of the Earth, seems impossibly large for a mere satellite. The diameter of the Moon is 3476 Km. or a little more than 1/4 that of the Earth. It is, therefore, thought that. like all other planets, the Moon originated in a cold state at the same time when the solar system was formed. It seems therefore, preferable to regard the Earth-Moon system a double planet.

(See *Phases of the Moon* at page 231).

* * *

Observer's Latitude : 25°N

NOVEMBER ZENITH NIGHT - SKY

July	1 at 5 a. m.	(I. S. T.)
August	1 at 3 a. m.	
October	1 at 11 p. m.	
November	**1 at 9 p. m.**	
December	1 at 7 p. m.	

July	15 at 4 a. m.	(I. S. T.)
August	15 at 2 a. m.	
October	15 at 10 p. m.	
November	**15 at 8 p. m.**	
December	15 at 6 p. m.	

Phases of the Moon

THE MOON is invariably a pleasant sight of the night sky. Neither the Moon's position nor its shape and appearance are the same from night to night. They go through a cycle in 29 days.

The Moon is not self-luminous. It receives light from the Sun.

If the Moon is between the Earth and the Sun, we have the entire non-illuminated side towards us. This is New Moon. As the Moon proceeds on its course about the Earth, the light from the point of view of the observer on Earth appears first in the west in the form of a crescent. After this, the Moon's disc is half illuminated. This represents one-quarter of the lunar month. Before the Moon's disc becomes fully illuminated, as on Full Moon day, it passes through a phase known as gibbous. The cycle is reversed in the next fortnight and after 29 days we get once more the New Moon.

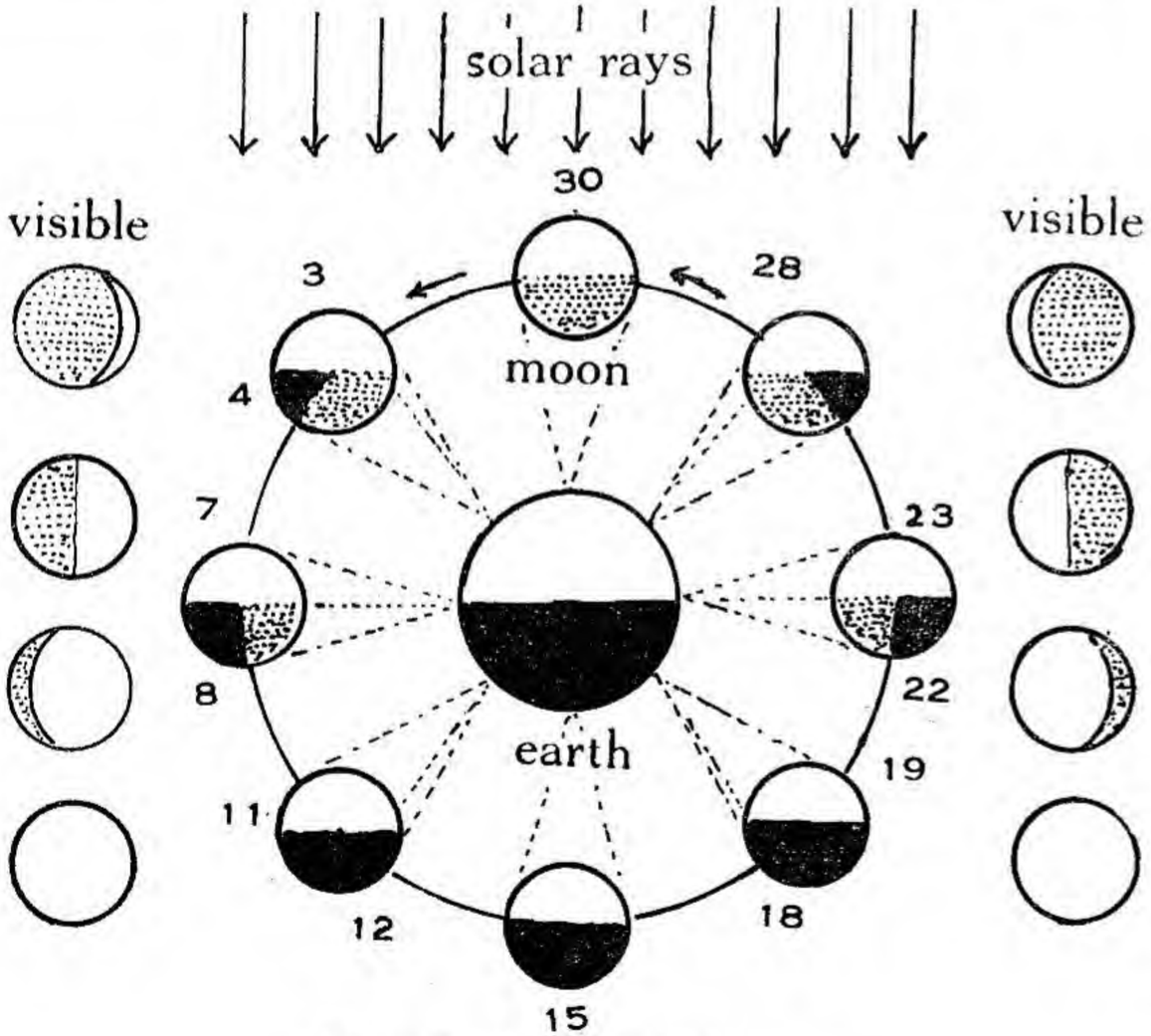


Fig. 11.9 : Phases of the Moon

According to Indian reckoning, there are two halves of the lunar month. The waxing period from New Moon to Full Moon is called. *Śukla Pakṣa* (शुक्ल पक्ष) and the waning period from Full Moon to New Moon in the second half is called *Vadya Pakṣa* (वद्य पक्ष). According to Indian terminology New Moon is *Amāvāsyā* (अमावास्या), and Full Moon is *Pūrṇimā* (पूर्णिमा).

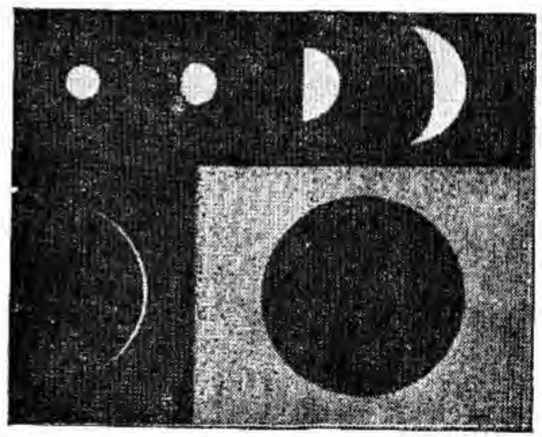
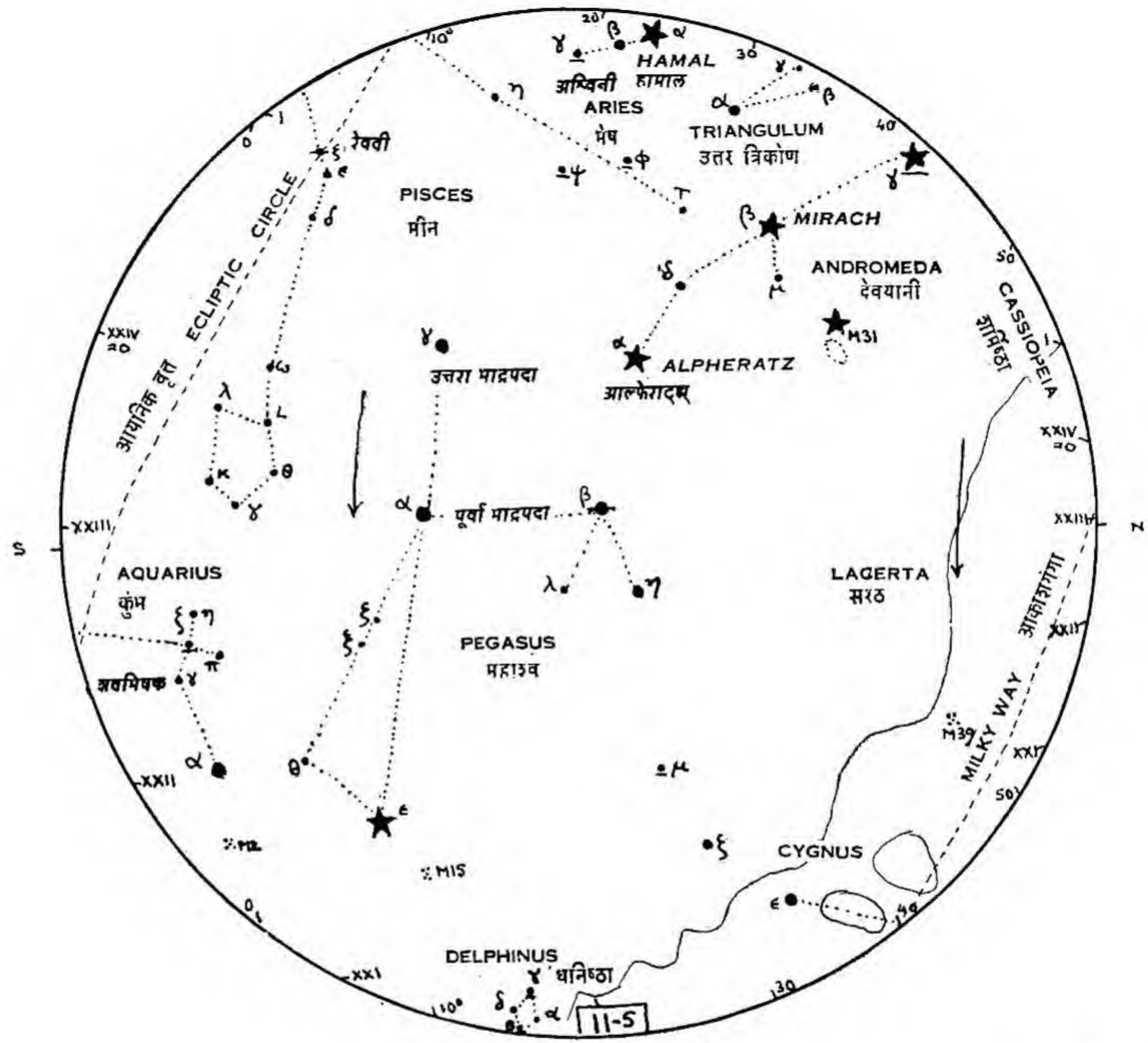


Fig. 11.10 : Phases of Venus and its apparent changing size.

Fig. 11-11 : Earth appearing to be a crescent Moon
(Photograph from an artificial Satellite.)

Venus and Mercury are inner planets and they fulfil the conditions necessary for the production of 'phases' just as in the case of the Moon. There is, however, this difference that the sizes of visible discs and their illuminated portions vary considerably. The reason for this phenomena is the fact that both Venus and Mercury, during their revolutions round the Sun, come very close and go very far from us unlike the Moon that keeps almost a uniform distance.

* * *



Observer's Latitude : 25° N

NOVEMBER ZENITH KEY - MAP

July	1 at 5 a. m. (I. S. T.)	July	15 at 4 a .m. (I. S. T.)
August	1 at 3 a. m.	August	15 at 2 a. m.
October	1 at 11 p. m.	October	15 at 10 p. m.
November	**1 at 9 p. m.**	**November**	**15 at 8 p. m.**
December	1 at 7 p. m.	December	15 at 6 p. m.

Comet

A COMET that can be seen with naked eyes is one of the most attractive sights in the night-sky; but it is a very rare occurrence. A Comet is a small heavenly body belonging to the solar system. It revolves about the Sun in a very elongated orbit.

The Comets form a particular group of more or less hazy looking objects. They have tails of varying lengths and shapes. Comets appear from time to time and move across the sky, as the planets do. The appearance of a Comet varies greatly according to its distance from the Sun. It is, therefore, not possible to identify a Comet, merely by its appearance, whenever it does appear. There are many Comets that can be seen with a telescope, but the number of Comets seen with naked eyes is exceedingly small. Complete identity of a Comet can be established only after its orbit is well defined.

When a Comet's motion in space is traced out, it is found to describe a closed orbit round the Sun. Most of these orbits are very elongated, with the result that a Comet becomes visible only when it comes relatively close to the Sun. The orbits of some 500 Comets have been more or less accurately calculated from observations made during their visibility, telescopic or otherwise. Some Comets have very elongated orbits, so much so that their periods of revolution round the Sun are several hundred years.

The most famous periodic Comet is the one named after the British astronomer Halley. Halley found in the year 1705 that the Comets, previsously observed by others in 1531, 1607 and 1682, had followed nearly an identical orbit in space. From this result Halley concluded that the Comet would return, after a period of 76 years. Correct to this prediction, the Comet did actually appear in the year 1759. Afterwards, this Halley's Comet returned in 1835 and 1910. This Comet is expected to turn up again in the year 1986 !!

A great deal has been learnt about the true nature of Comets. They are somewhat transparent. Bright stars can be seen right through the tail of a Comet. A comet consists of a nucleus, called the head, of solid particles and frozen gas. The head is surrounded by a hazy envelope called 'coma.' When a Comet, in its orbit, approaches the Sun, gases are driven off from the head under radiation pressure by positively charged solar particles, so that a tail is formed. The tail is, therefore, always directed away from the Sun. As a Comet moves further away from the Sun again, the tail disappears slowly into space. The tail of the Great comet of the year 1843 had an estimated length of 324 million kilometers, which is more than twice the distance from the Earth to the Sun ! !

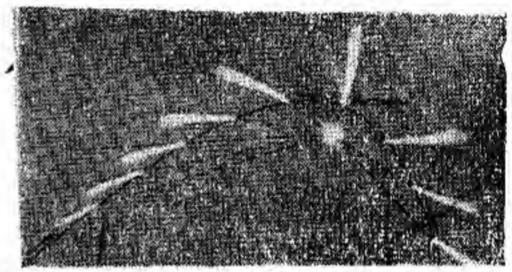


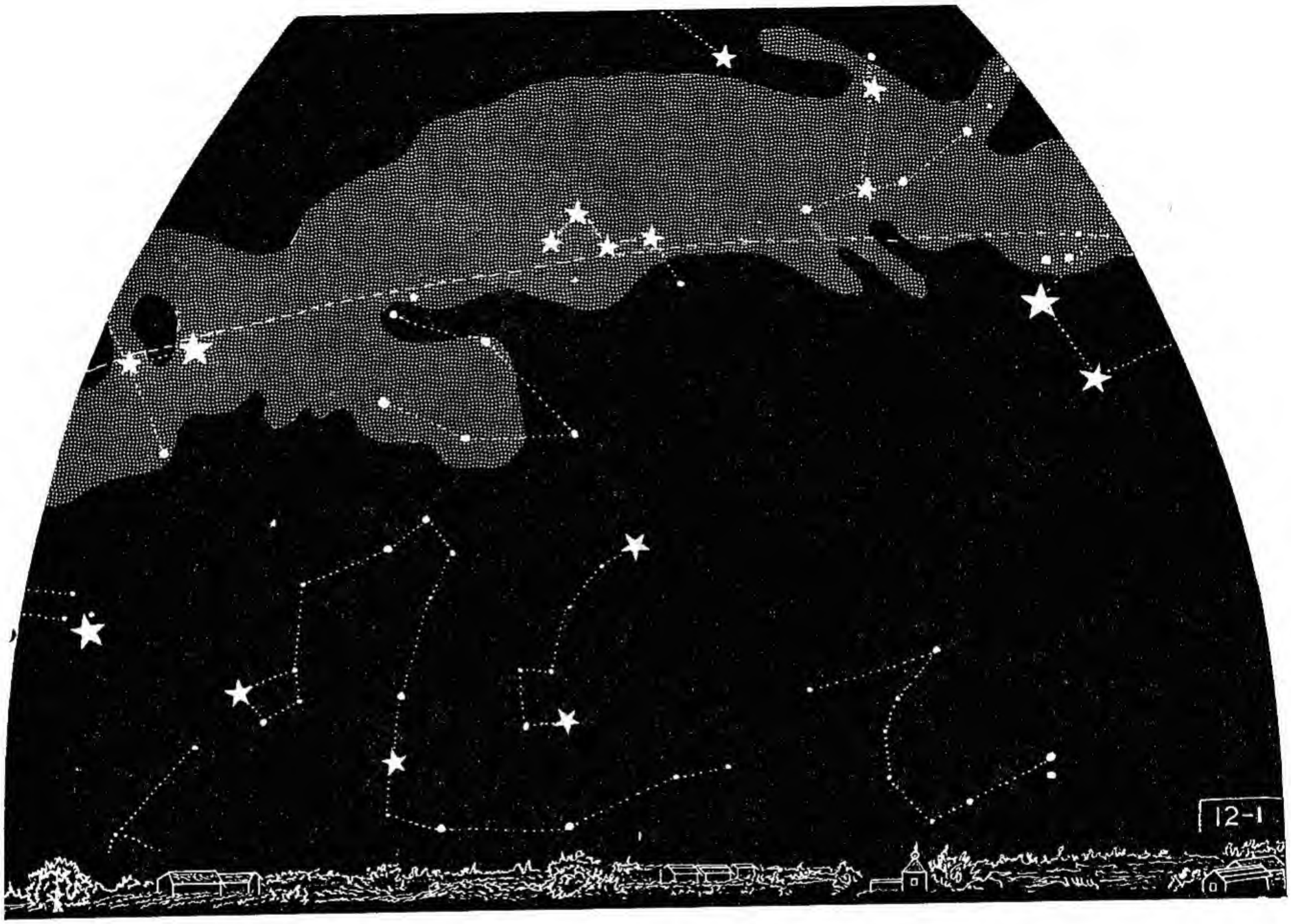
Fig. 11.12 : The tail of a Comet is always turned away from the Sun.

The Comet, seen with naked eyes in India, was the Ikeya-Saki during September, October and November of 1965. It was first seen during its approach and later during its retreat from the Sun. Ikeya and Saki are Japanese amateur observers and they studied the Comet with the help of their home-made telescopes !! The last Comet visible with the naked eyes was Benet, in 1970. Benet is a South African amateur astronomer, who discovered the Comet.

As regards the origin of Comets, it is believed that there exists a hypothetical cloud containing about 100,000 million *comet-heads* with a combined mass of 1/10 to 1/100 that of the Earth. The centre of the cloud coincides with the Sun, while its outer edges are more than 100, 000 astronomical units distant from the Sun. It appears, therefore, that there is an endless supply of new Comets.

The influence of the planets, especially Jupiter, occasionally accelerates a comet so that it leaves the solar system in a hyperbolic orbit and gets lost for ever. The extensive nature of the Comet cloud makes it possible not only for Jupiter but also for the nearest fixed stars to disturb the orbits of Comets.

* * *



Observer's Latitude : 25°N

DECEMBER
NORTH
NIGHT-SKY

August	1	at	5	a. m. (I.S.T.)	August	15	at 4 a. m. (I. S. T.)
September	1	at	3	a. m.	September	15	at 2 a. m.
November	1	at	11	p. m.	November	15	at 10 p. m.
December	**1**	**at**	**9**	**p. m.**	**December**	**15**	**at 8 p. m.**
January	1	at	7	p. m.	January	15	at 6 p. m.

Perseus

THE CONSTELLATION is situated in the middle of the Milky Way and between Andromeda* and Auriga. It is one of the few constellations which are rich in stars.

In Indian astronomy, the constellation is called *Yayāti* (ययाति). *Yayāti* was a king who rescued *Devayānī* (देवयानी) from a well and later married her with the consent of her father *Sukrācārya* (शुक्राचार्य), sage and teacher of *Vṛṣparva* (वृषपर्वा)

According to Greek mythology, Perseus was the son of Zeus and princess Danae. The story of his birth resembles the story of the birth of *Shrikṛṣṇa* (श्रीकृष्ण) in *Mahābhārata*.

Acrisius, the King of Argos, was very selfish and quarrelsome. He was warned by Jupiter that one day he would lose his crown, and suffer death at the hand of his own grandson. With a view to circumvent this, Acrisius kept his own daughter Danae locked up in an underground room and hoped that she would have no child. Zeus, the amorous God, somehow, managed to visit Danae secretly and Persues was born of Danae. When the King Acrisius came to know of this, he got furious, put both the mother and the child in a box and threw the box into the sea. The box, however, fell into the hands of a kind fisherman, who took it and carried it home. The mother and the child lived in the fisherman's house until Perseus was grown up. The King came to know of this incident and deliberately sent Perseus on a dangerous mission of securing the head of the terrible Gorgon Medusa. Medusa was hideous and was cursed, so that if any body looked at her eyes he would be turned into a stone. When Perseus went on his mission to kill Medusa, he was already forewarned and provided with a shield to protect himself. The shield was shining like a mirror, so that Perseus needed only to look at the reflexion of Medusa in the mirror. Perseus did as he was told and killed Medusa and captured her head.

* See *Andromeda* at page 219 and *Cassiopeia* at page 215

This hero Perseus was the saviour of Andromeda from the sea monsters. Afterwards, the legend says, the old prophecy came to be true, because Acrisius, the grand-father, was accidentally killed by a discus thrown by Perseus at some later date.

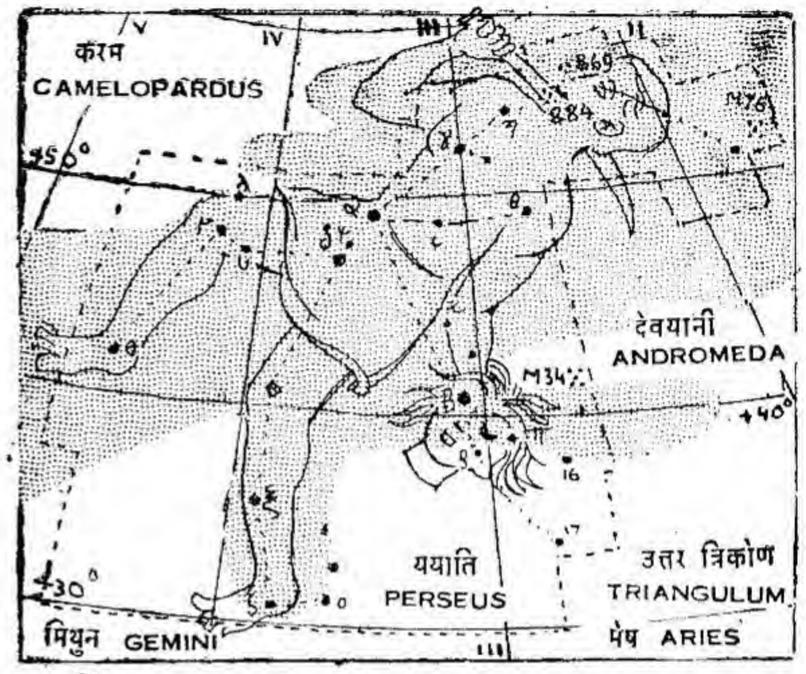


Fig. 12.1 : Perseus (Yayāti)

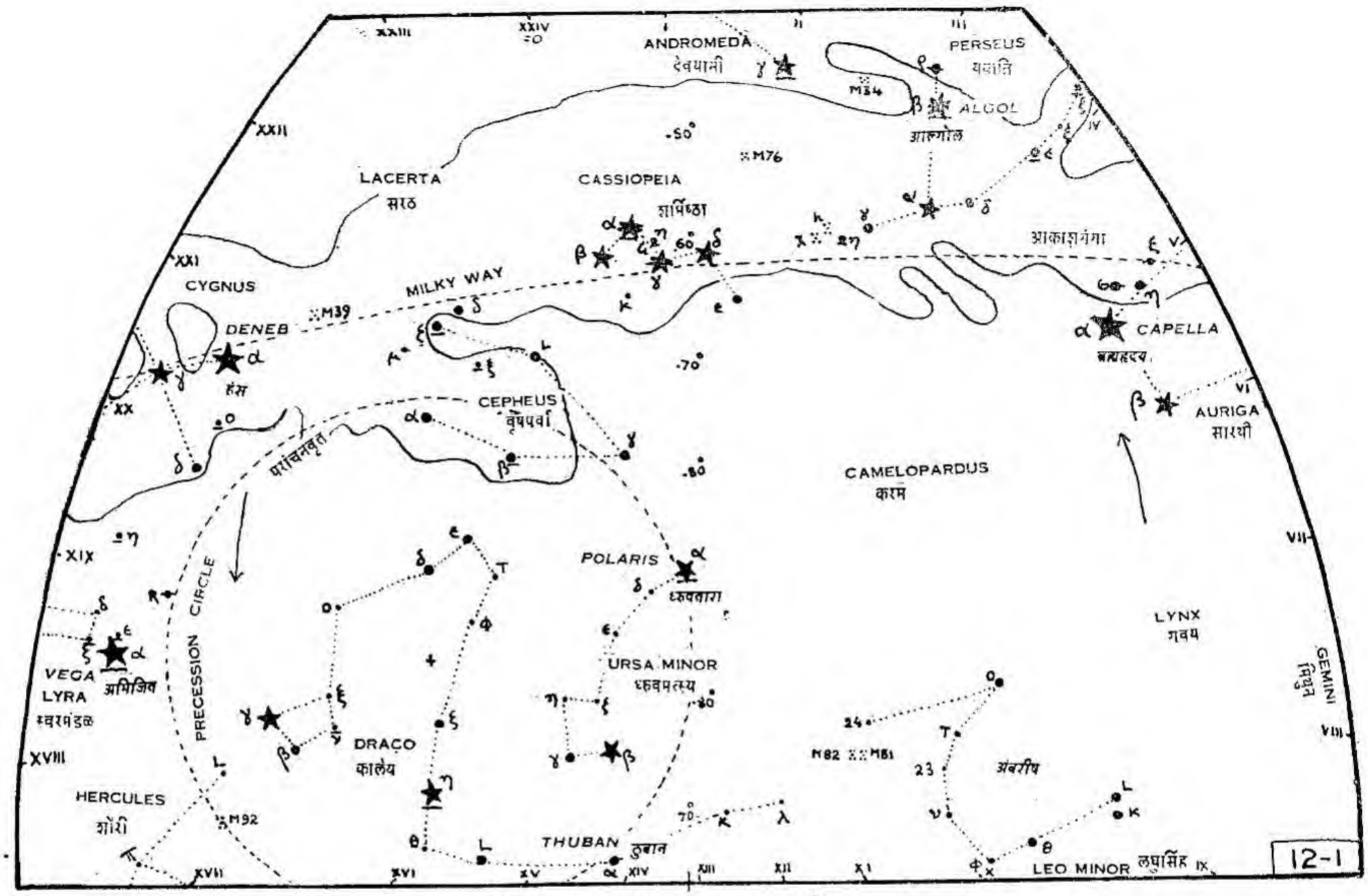
The star α of Perseus is called Mirfach.

The star β, known as Algol, is a variable and it is also called the Devil's star in Arabic. The change in its brightness is due to the fact that Algol has a companion and while going round each other, one eclispses the other. There is also a third star in the system.

The Star Clusters *h* (NGC 869) and χ (NGC 889) of Perseus are interesting even in a field-glass. (See page 109 column 2).

A Meteoric Shower appears in the neighbourhood of the constellation Perseus about the 10th. of August and the phenomena have been recorded from as far back as 811 A.D. The shower is known as Perseids, and it has been very regular.

* * *



Observer's Latitude : 25°N

DECEMBER
NORTH
KEY - MAP

August	1 at 5 a. m. (I. S. T.)	August	15 at 4 a. m. (I. S. T.)
September	1 at 3 a. m.	September	15 at 2 a. m.
November	1 at 11 p. m.	November	15 at 10 p. m.
December	**1 at 9 p. m.**	**December**	**15 at 8 p. m.**
January	1 at 7 p. m.	January	15 at 6 p. m.

DECEMBER : NORTHERN SKY

Prominent Stars :

α in Auriga (Capella).

α, β (Shedar and Caph) and three other stars in Cassiopeia, making the English letter M or W.

α, β in Cygnus (Deneb, Albireo).

α in Draco (Thuban), former Pole Star.

α in Lyra (Vega), future Pole Star.

β in Perseus (Algol).

α in Ursa Minor (Polaris), present Pole Star.

Double Stars :

γ in Andromeda, gold and blue, seen through a small telescope.

γ in Aries, interesting double for a 5 cm. telescope.

η in Cassiopeia, period 526 days, seen with a 5 cm. telescope.

β, ξ in Cepheus. β is a spectroscopic binary, seen with a 5 cm. telescope.

ε, ζ, η in Cygnus, seen with a field-glass.

o_2 in Cygnus is a triplet

β in Perseus, eclipsing binary, one dark and one bright component. It has 2 more components, making it a quadruple.

α in Ursa Minor, wide double 18″ apart, seen with a 5 cm. telescope.

Variable Stars :

δ in Cepheus, a typical variable with a period of 5.37 days.

χ in Cygnus, Mira type with a period of 413 days. Varies through 10 magnitudes.

β in Perseus, regularly variable, period 2 d. 20 hrs. 48.9 min.

Nebulae and Star Clusters :

M 39 (NGC 7092) in Cygnus, beyond α and near π^2 Opencluster. seen with field-glasses.

h (NGC 869) and χ (NGC 884) in Perseus, bright diffuse spots, seen with naked eyes.

M 81 (NGC 3031) M 82 (NGC 3034) in Ursa Major, both can be seen together in a low power field-glass.

* * *

(Continued from page 227 column 2)

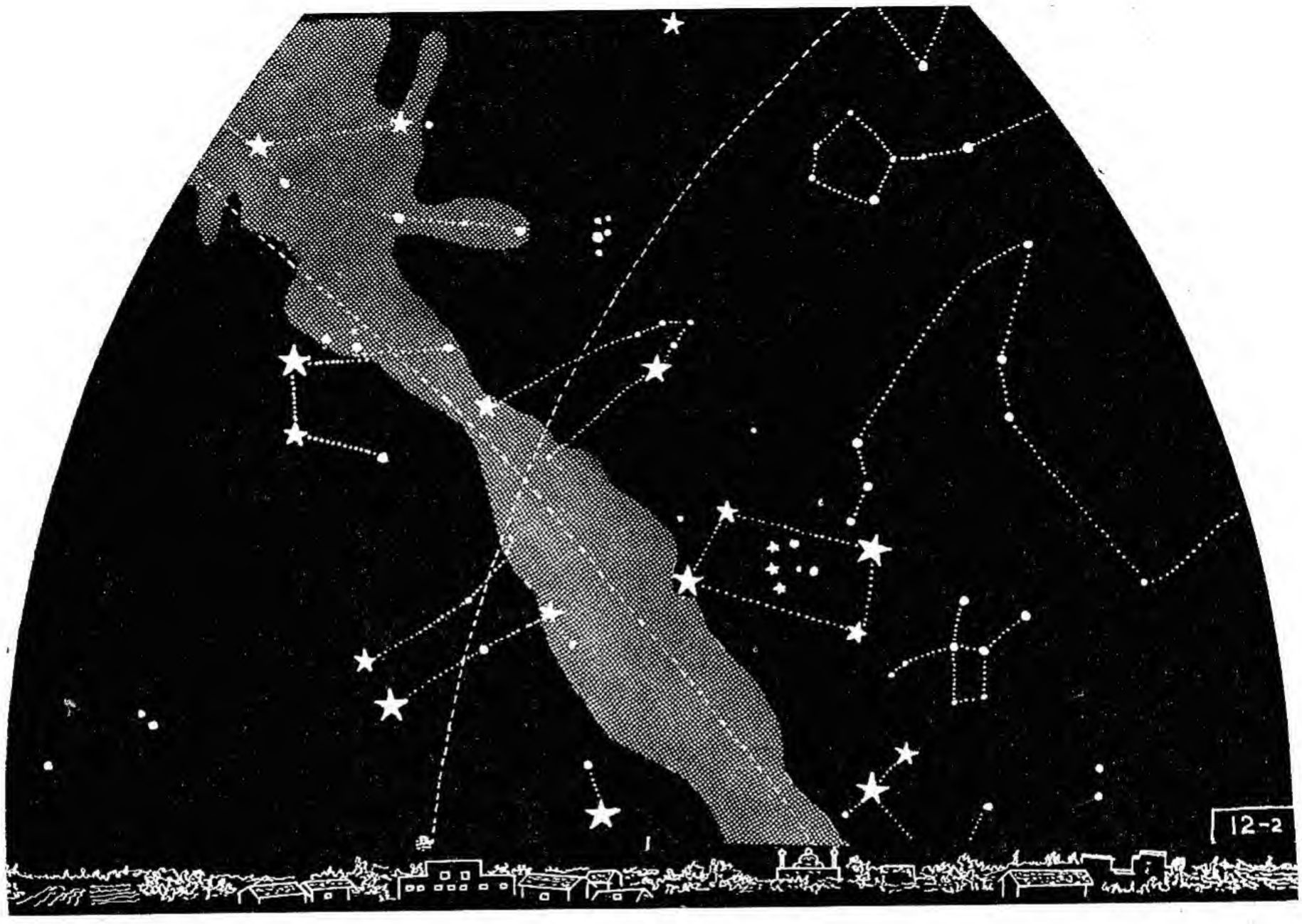
Pulsars

was only from 10 to 20 milli-seconds. This provided certain clues to the nature of this radio emission : (1) The body emitting the pulses had to be extremely small. Its radius would not be greater than a few thousand kilometers. (2) The second clue about the nature of the source was provided by the frequency distribution of the pulses, which gave an important indication of the distance of the emitter.

The ionized interstellar matter produces dispersion of the radio waves constituting the sharp emitted pulses. The result is that shorter wave-lengths arrive at the earth slightly before the longer wavelengths. Knowing the difference in the times of arrival, an estimate could be made of the distance of the radio source. The first ' Pulsar ' was thus found to be at a distance of about 130 par-secs from us, and it is within our galaxy, which has a diameter of about 30,000 par-secs.

The problem concerning the period of " Pulsars " is somewhat complicated since periods ranging from a quarter af a second to a *few milli-seconds* have been observed. They could not be fitted with the *vibrational periods* either of white dwarfs or the neutron stars. There is another and possibly better explanation about the behaviour of the Pulsars. They could be regarded as spinning objects, beaming their radio-energy into space like some giant rotating beacons. Confirmation of this theory came in gradually. Such sources were located in the constellation Vela, a remnant of a super-nova and two sources in the Crab nebula. One of them being a small spinning neutron star, a massive pigmy of about 10 Km diameter.

* * *



Observer's Latitude : 25° N

DECEMBER EAST NIGHT-SKY

August	1 at 5 a. m. (I. S. T.)			August	15 at 4 a. m. (I. S. T.)
September	1 at 3 a. m.			September	15 at 2 a. m.
November	1 at 11 p. m.			November	15 at 10 p. m.
December	**1 at 9 p. m.**			**December**	**15 at 8 p. m.**
January	1 at 7 p. m.			January	15 at 6 p. m.

Quasars

QUASI–STELLAR OBJECTS or 'Quasars' are considered to be among the most distant objects known. Their distance from us may be as much as 10,000 million light-years. The Quasars are neither stars nor galaxies. In the photographs taken with the world's greatest telescope they appear to be faint, round, misty spots of light. Drawings based on the concept of a Quasar show an exploding star at the centre of a huge cloud of expanding gases.

Light, that informs us about the presence of these extraordinary objects that lie at a vast distance away in the sky, was set on its journey hundreds of millions of years ago. At that time, as far as we know, the Sun and the Planets were yet to be formed, the universe was much smaller than it is now and the galaxies were young. It appears that the Quasars, as we see them now, represent the primitive stage of the evolution of the universe.

The radio waves coming from a Quasar were first detected in 1960, with the help of a Radio Telescope. Many Quasars were discovered soon after. It was first believed that the Quasars were hot and dense stars, situated not far from the Sun. The Astronomers Sandage and Greenstein studied the spectrum of a Quasar. The Spectrum was found to be quite different from that of other objects. Dutch scientist Maarten Schmidt measured the shift of the Hydrogen line and calculated that the radial velocity of the source was 50,800 Km per second. This was in the case of the Quasar known as 3C-273. Other Quasars are now known to have larger spectral red-shifts and distances verying between 4,000 million to 1,500 million light-years.

These immense distances indicate that the Quasars are extremely bright objects. For comparison, if the Milky Way were so far away with its millions of stars, the light our Earth would have received from it would have been only 1/100th of that we receive from a Quasar. A Quasar is estimated to have an energy output greater than hundred Milky Ways put together !

Oddly enough, on the universal scale, the diameterrs of Quasars are small, being only about 10 light-days. How these small objects can produce such tremendous amounts of energy is still an unsolved puzzle. According to Prof. Fred Hoyle, the Quasars were giant stars, with their stock of hydrogen now exhausted, and consequently rapidly shrinking in size. This state was described as *implosion*. The increasing density of the shrinking object is believed to be the source of the tremendous energy released by a Quasar. Extremely powerful gravitational field would be needed to produce so much energy; but if there was such a powerful gravitation field around a Quasar, it would also mean that even light would not be able to escape from it. This point is, however, still unexplained.

Physicist Hans Alfven explains the above phenomena in a different way. There are, in the universe, sub-atomic particles like protons, electrons and so on. There are also corresponding anti-particles. When brought together, the particles and anti-particles are converted into energy with a great explosion. Matter and anti-matter annihilate each other, and tremendous energy is released in the process. Though there is no anti-matter around us, it seems reasonable to assume that there exist many galaxies and clusters of galaxies formed entirely of anti-matter. According to H. Alfven, matter and anti-matter collide and result in the production of energy and of Quasars.

More than hundred Quasars are known already and the red-shifts of about thirty of them have been measured. One Quasar is found to be rushing away from us at a terrific speed of about 82% of that of light. Some consider that Quasars were plentiful when the universe was born and now they are slowly dying out.

We know that the faster is the galaxy's speed, the farther off it is from us. We can therefore calculate how fast an object, at the distance of Quasars, should move. The Quasars seem to have velocities greater than the velocities obtained by calculation. We see the Quasars, not as they are now, but as they were long long ago. This would mean that the universe is now expanding at a greater rate than in the past. This fact supports the expansion-contraction theory.

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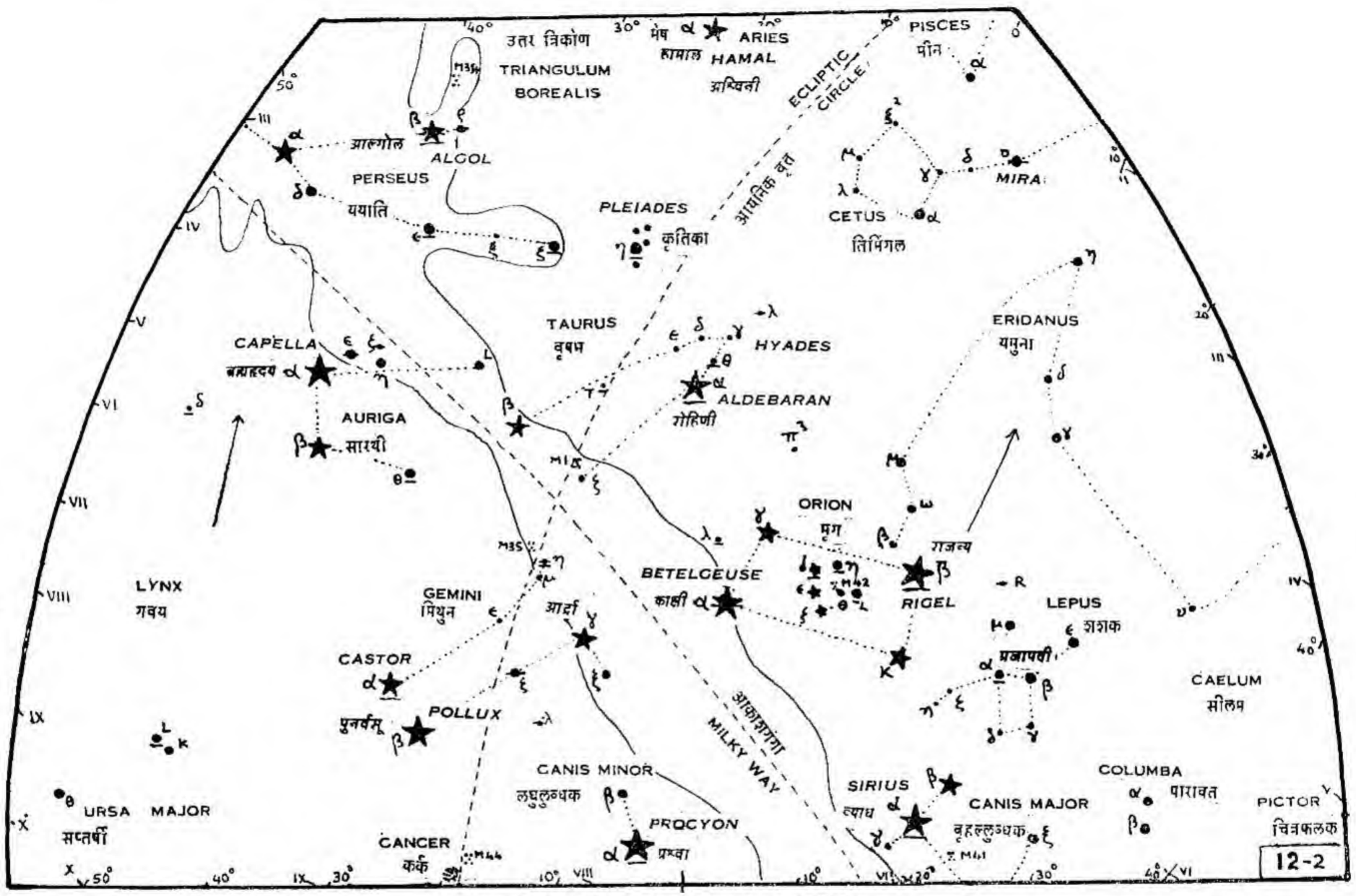

Observer's Latitude : 25°N

August	1 at 5 a. m. (I. S. T.)			August	15 at 4 a. m. (I. S. T.)
September	1 at 3 a. m.			September	15 at 2 a. m.
November	1 at 11 p. m.	**DECEMBER**		November	15 at 10 p. m.
December	**1 at 9 p. m.**	**EAST**		**December**	**15 at 8 p. m.**
January	1 at 7 p. m.	**KEY-MAP**		January	15 at 6 p. m.

DECEMBER : EASTERN SKY

Prominent Stars :

α in Auriga (Capella).
α in Canis Major (Sirius).
α in Canis Minor (Procyon).
o in Cetus (Mira).
α in Eridanus (Achernar).
α, β in Gemini (Castor and Pollux).
α in Taurus-Hyadas (Aldebaran).
η in Taurus-Pleiades (Alcyone).
β in Perseus (Algol).
α, β in Orion (Betelgeuse, Rigel).

Double Stars :

β in Orion, seen with a 5 cm. telescope.
θ_1 in Orion, seen with a 5 cm. telescope, it consists of 4 stars.
θ_1, θ_2, δ in Orion, seen with a binocular or a field-glass.
β in Perseus, eclipsing binary, 2 more components make it a quadruplet
ε, ζ, η in Perseus, seen with a 5 cm. telescope.
α in Taurus, wide double 112″ apart. Components of magnitude 1.0 and 11.2.
θ in Taurus, visible with naked eyes.
τ in Taurus, visible with a field-glass
η in Taurus, wide double, 20-30 stars seen through field-glasses.

Variable Stars :

o in Cetus, first discovered variable. Period 332 days.
α in Orion, irregularly variable
β in Perseus, regular short period variable.
λ in Taurus, eclipsing variable. Algol type, 3.3 to 4.2. magnitudes.

Nebulae and Star Clusters :

M 41 (NGC 2287) in Canis Major, about 5° below Sirius, seen with naked eyes.
M 42 (NGC 1976) in Orion, below σ. The great Orion Nebula, seen with naked eyes.
h (NGC 869) and χ (NGC 884) in Perseus, beautiful bright spots, seen with naked eyes.
M 76 in Perseus, near ζ, Dumb-bell shaped. This belongs to our galactic system.
M 1 in Taurus, near ζ. This is called 'Crab Nebula'. It is a strong source of radio emission.

* * *

Radar

RADAR IN astronomy is restricted to objects within the solar system. The principle is as for aircraft detection—a pulse of radio radiation is transmitted and the small amount of it that is reflected back from the object is received on radio antenae. The direction from which the echo returns can be measured and also the time delay between emitting the pulse and receiving the reflected signal. Assuming the velocity of light, the latter gives the distance of the object. Radio contact was made with Moon in 1946 and with Venus in 1958.

* * *

Quadrant

THIS IS the name of an instrument, formerly used in astronomy, to measure the elevation of stars. It consists of a graduated arc of 90°. It was used, for instance, by Tycho Brahe in measuring the positions of Planets.

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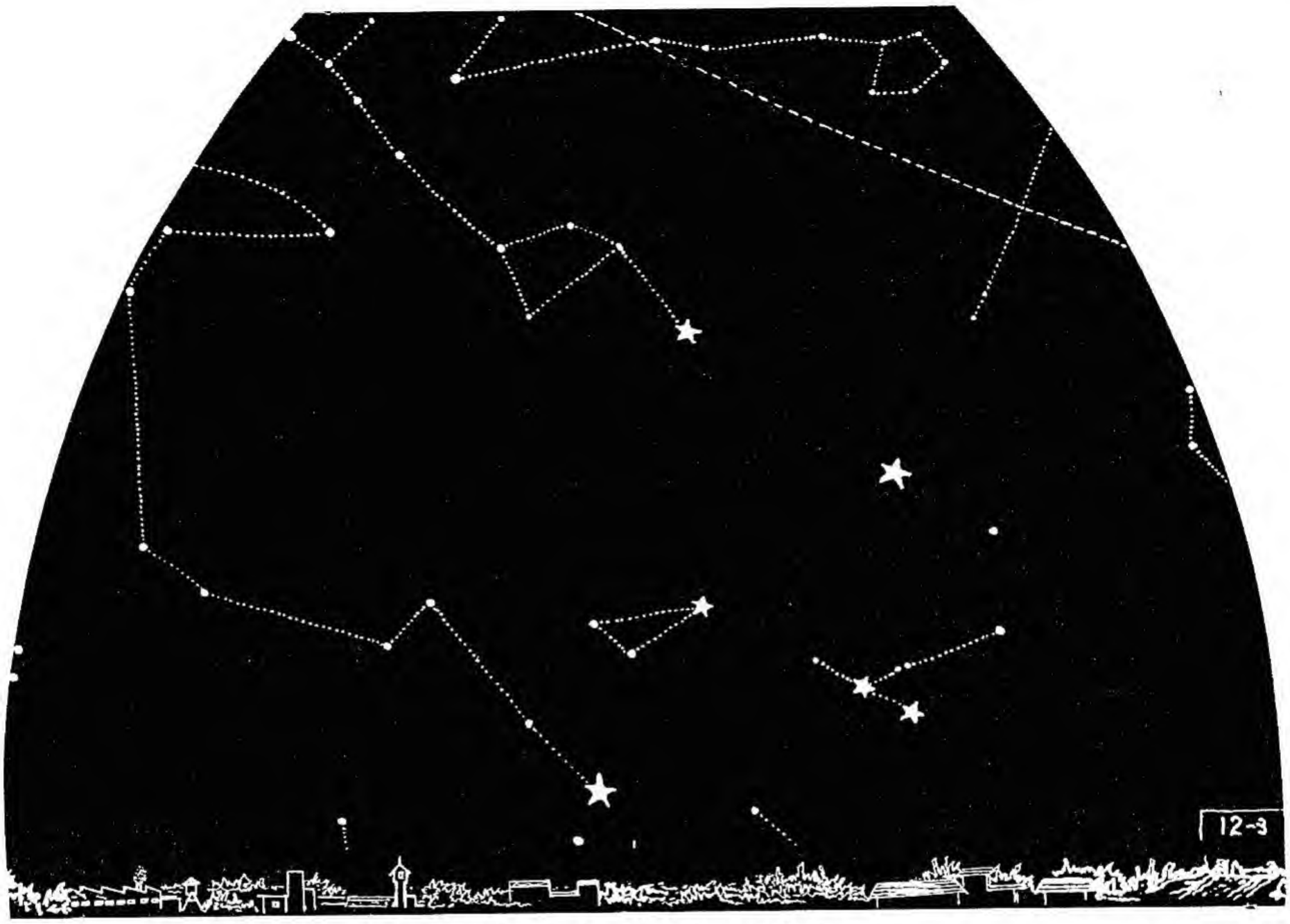


Observer's Latitude : 25° N

DECEMBER SOUTH NIGHT-SKY

August	1 at 5 a. m. (I. S. T.)	August	15 at 4 a. m. (I. S. T.)
September	1 at 3 a. m.	September	15 at 2 a. m.
November	1 at 11 p. m.	November	15 at 10 p. m.
December	**1 at 9 p. m.**	**December**	**15 at 8 p. m.**
January 1	1 at 7 p. m.	January	15 at 6 p. m.

Nuclear Reactions

THE SOURCE of the tremendous and inexhaustible energy given out by the Sun and the Stars is now considered to be the nuclear reactions going on in their interiors.

The simplest of all atoms is Hydrogen and it is made up of one Proton (a charge of positive electricity) and one Electron (an equal charge of negative electricity). All the mass of the Hydrogen atom is supposed to be in the Proton. The Electron has practically no mass. Protons and Electrons are extremely small in size and they are regarded as the ultimate particles of matter. A Proton forms the Nucleus of the Hydrogen atom and an Electron circles continuously about the the nucleus at some distance. This is the picture of the Hydrogen Atom.

There is another kind of ultimate particle, known as the Neutron and it has approximately the same mass as that of the Proton, but it carries no electrical charge with it. This fact explains its name Neutron. As atoms become more massive than the Hydrogen atom, they contain some more Protons and some more Neutrons. Helium, for instance, the next massive atom to Hydrogen contains in its nucleus 2 protons and 2 neutrons.

The reaction which brings about the transformation of the Hydrogen nucleus into a Helium nucleus is called a nuclear reaction. It is the one which mostly occurs in the interiors of stellar bodies. The energy given out in the process gives all the light and heat and other particles charged with kinetic energy.

It is customary to speak of a nucleus instead of an atom. The difference is obvious. An atom deprived of its encircling electrons becomes the nucleus. There are different atoms, because their nuclei are different. The atomic nuclei of the various elements are formed by bringing about different combinations of Protons and Neutrons. Addition of a Proton or removal of a Proton, therefore, brings about a transformation of the nucleus. This change is brought about in a nuclear reaction.

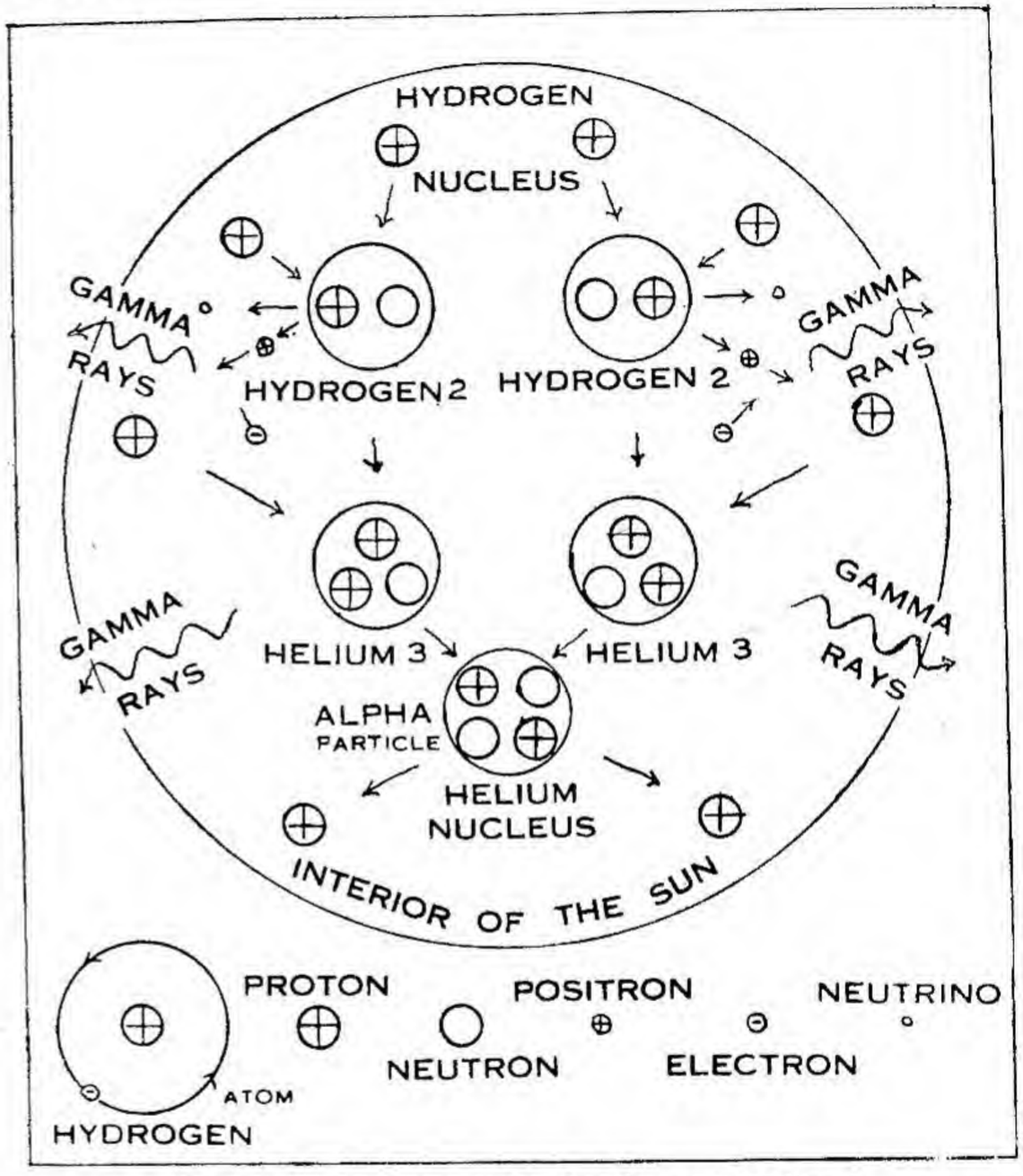
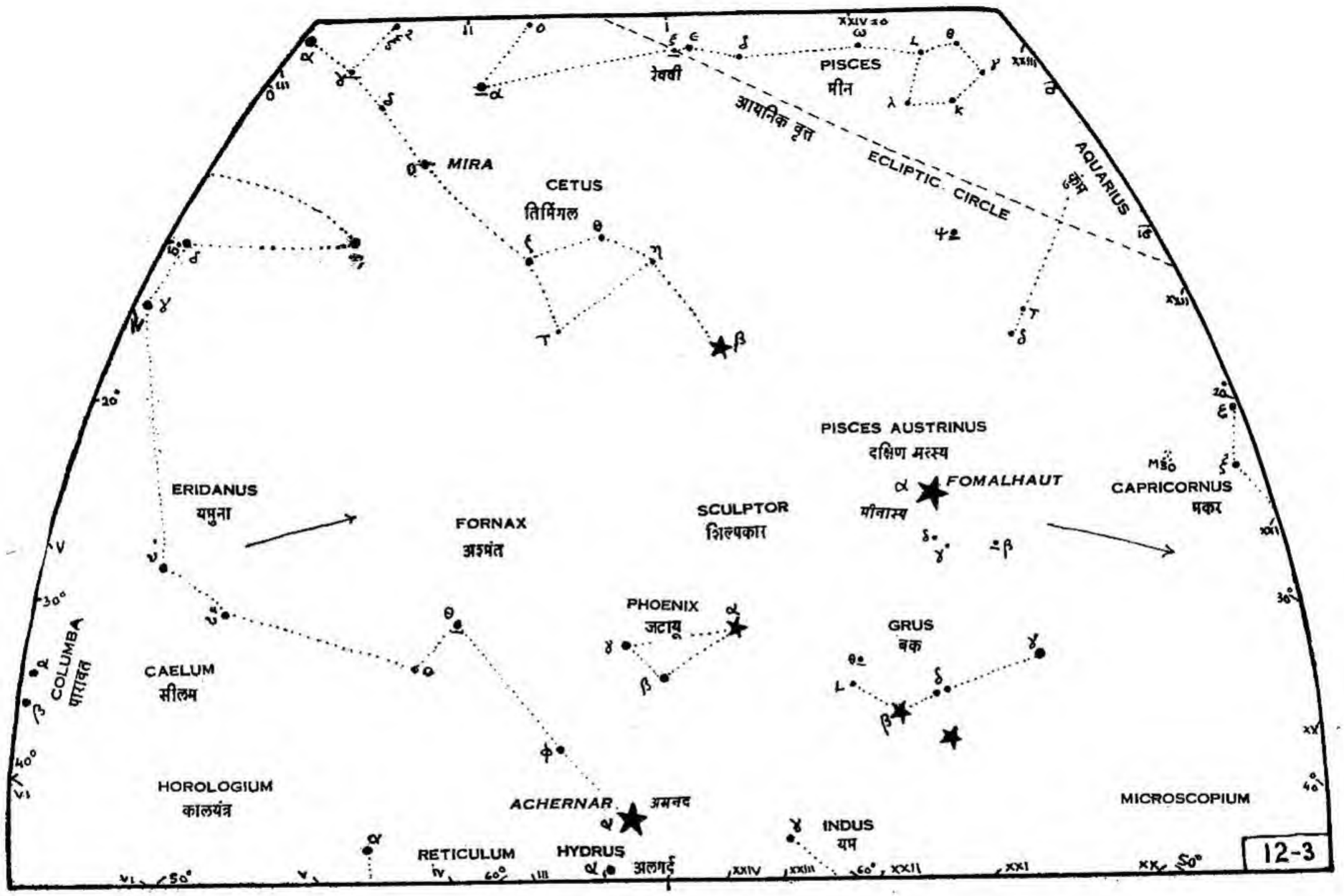


Fig. 12.3 : Nuclear reaction (Hydrogen to Helium)

The nucleus of an atom is held together by a special force of attraction between the particles. This force is called the Binding Force. If this special force were not present in the nucleus, the similarly charged Proton particles would fly away from each other and the nucleus would

(Continued on page 245 column 1)



Observer's Latitude : 25°N

DECEMBER SOUTH
KEY - MAP

August	1 at 5 a. m. (I. S. T.)	August	15 at 4 a. m. (I. S. T.)
September	1 at 3 a. m.	September	15 at 2 a. m.
November	1 at 11 p. m.	November	15 at 10 p. m.
December	**1 at 9 p. m.**	**December**	**15 at 8 p. m.**
January	1 at 7 p. m.	January	15 at 6 p. m.

DECEMBER : SOUTHERN SKY

Prominent Stars :

α, β, o in Cetus (Menka, Diphda, Mira).
α in Eridanus (Achernar).
β in Grus.
α in Phoenix.
α in Pisces Austrinus (Fomalhaut).

Double Stars :

θ in Grus. Magnitudes 4.5 to 7.0.
β in Pisces Austrinus, 30" apart of magnitudes 4.4 & 7.8.

Variable Stars :

o in Cetus, first discovered variable. Changes from magnitude 1.7 to 9.6 by a factor of 2100.

Nebulae and Star Clusters :

M 30 (NGC 7099) in Capricornus near ζ globular clusters, seen with field-glasses.

* * *

(Continued from page 243 column 2)

Nuclear Reactions

cease to exist. Like electric charges repel each other and unlike electric charges attract each other. But inside the nucleus, particles are protons and they carry like charges. The break-up of the nucleus is prevented by the extraordinary powerful Binding Force which comes to play among the particles at a very short range.

Alteration of the Proton contents ot the nucleus brings about a transformation and the agency for that is the Nuclear Reaction. Hydrogen, under favourable conditions of temperature and pressure, can be converted into Helium. When this takes place a large quantity of energy, which was formerly employed in holding the original nuclei in the process, is now released. This energy is called Nuclear Energy.

Such transformations are constantly going on in the stars. When 4 Hydrogen nuclei are used up and 1 helium nucleus is created, several intermediate nuclei are formed and transformed. The net result is the change of Hydrogen into Helium and the liberation of energy.

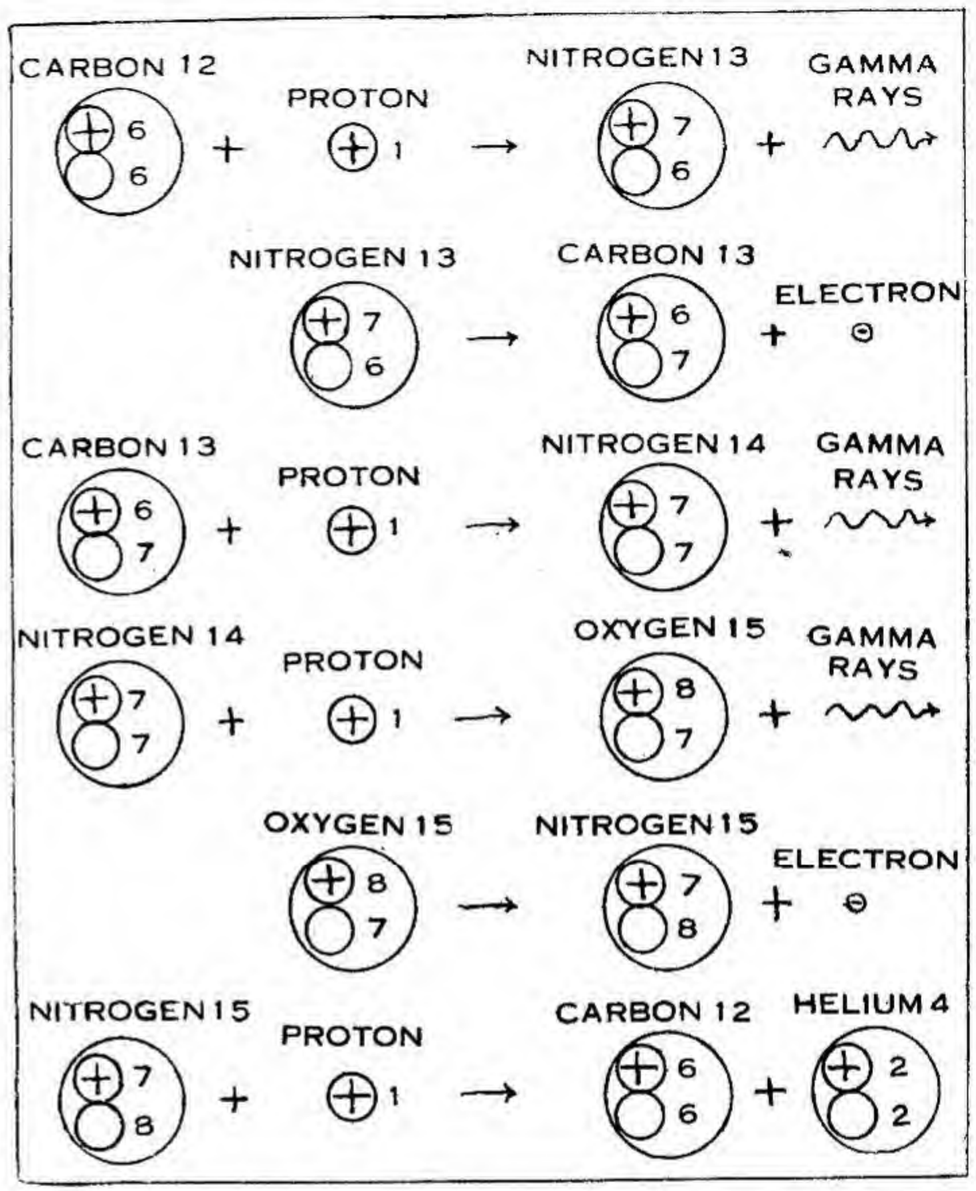


Fig. 12.4 : Nuclear reaction (Carbon cycle)

It is estimated that stars have a central temperature of about 15 million degrees Centigrade. Most stars contain an abundant supply of Hydrogen, Owing to nuclear reactions, Hydrogen is continuously transformed into Helium. Under special conditions, other chemical elements also come to be formed, as we have them on the Sun. But all these changes are called Nuclear Reactions and the Energy is Nuclear Energy.

* * *

Observer's Latitude : 25°N

DECEMBER
WEST
NIGHT-SKY

August	1 at 5 a. m. (I. S. T.)	August	15 at 4 a. m. (I. S. T.)
September	1 at 3 a. m.	September	15 at 2 a. m.
November	1 at 11 p. m.	November	15 at 10 p. m.
December	**1 at 9 p. m.**	**December**	**1d at 8 p. m.**
January	1 at 7 p. m.	January	15 at 6 p. m.

Aries

THIS IS a Northern Zodiacal Constellation, lying on the Ecliptic, between Taurus, Cetus and Triangulum, It contains 4 faint stars, the brightst of them α is called Hamal and it is of magnitude 2.23.

The Indian name of the Zodiac is *Meṣa* (मेष), meaning the Ram. According to Indian Astronomical conception, the constellation is *Aṣwinī* (अश्विनी) and it is represented by the stars α, β, γ (Hamal, Sheratan and Mesartim,) and the picture formed is that of a Horse's Mouth (*Aṣwa-Mukha*) (अश्वमुख).

At one time the principal star in Aries was very close to the equinoctial point and hence it is customary, even at the present time, to describe the same as the First Point of Aries. The present equinoctial point, ♈ in Pisces, is near stars α of Andromeda and γ of Pegasus.

In Vedic literature, *Aṣwinī* (अश्विनी) is described as being anxious to learn *Madhu Vidyā* (मधु विद्या) from sage *Dadhīci* (दधीचि). God *Indra*, (इंद्र) apprehending the potential danger, threatened *Dadhīci* that his head would be chopped off in case he transferred his skill to any one else. *Dadhīci* was, therefore, unwilling to teach. *Aṣwinī* then, suggested that the head of the sage *Dadhīci*, which really contained all the knowledge, should be quickly taken away and replaced by that of a horse. This extraordinary remedy was only partly successful because when *Indra* cut off *Dadhīci*'s head, it was only the horse' head and not the real head of the Sage, Moreover, *Aṣwinī* had not acquired all the knowledge from him. This appears to be the reason why the constellation is shown as the head of a horse.

According to Greek mythology, Aries was a ram, who could fly and who was covered with what came to be known as the Golden Fleece. The Queen of Thessaly had two step-children, by name, Helle and Prixus. The King used to persecute them. Mercury took compassion on the children and desired to protect them. Therefore, he brought this ram Aries so that the children could climb upon its back and escape. On the way to safety, Helle lost control, fell into the sea and was drowned. The place where this occurred came to be called Hellespont, now known as the Dardanelles. The other child Prixus safely completed the journey and offered the Ram to God Jupiter, who placed it among the stars.

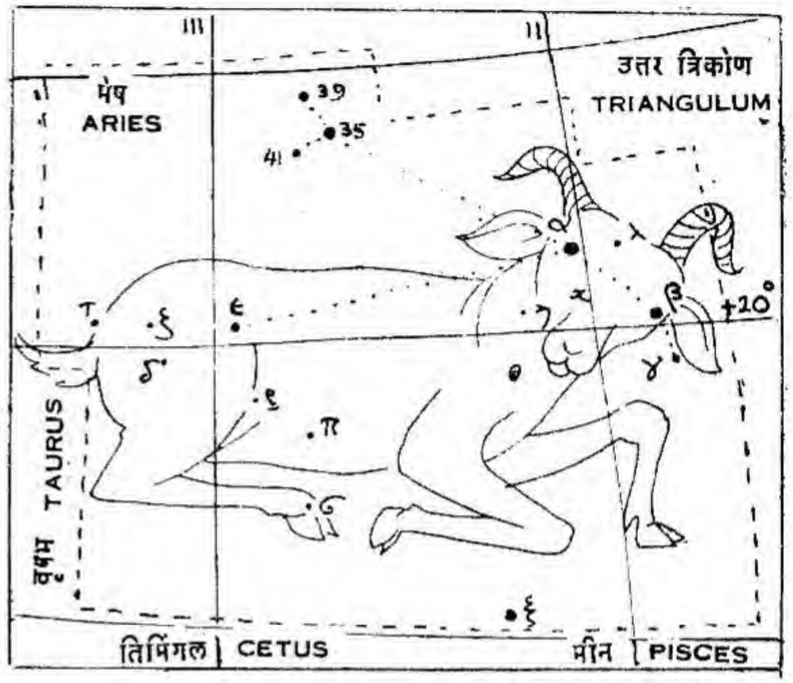


Fig. 12.5 : Aries (Mesa)

The legend of the Golden Fleece is mentioned in connection with the constellation Argo Navis* of old. This was originally the ship used in the Argonautic expedition to obtain the Golden Fleece. This extensive constellation is now broken up into four separate constellations, known as Carina the Keel, Vela the Sails, Pyxis the compass, and Puppis the Stern.

The star γ is an interesting double and can be seen with a 5 cm telescope.

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* See *Argo Navis aad others* at pages 63, 65, 67 and 69.

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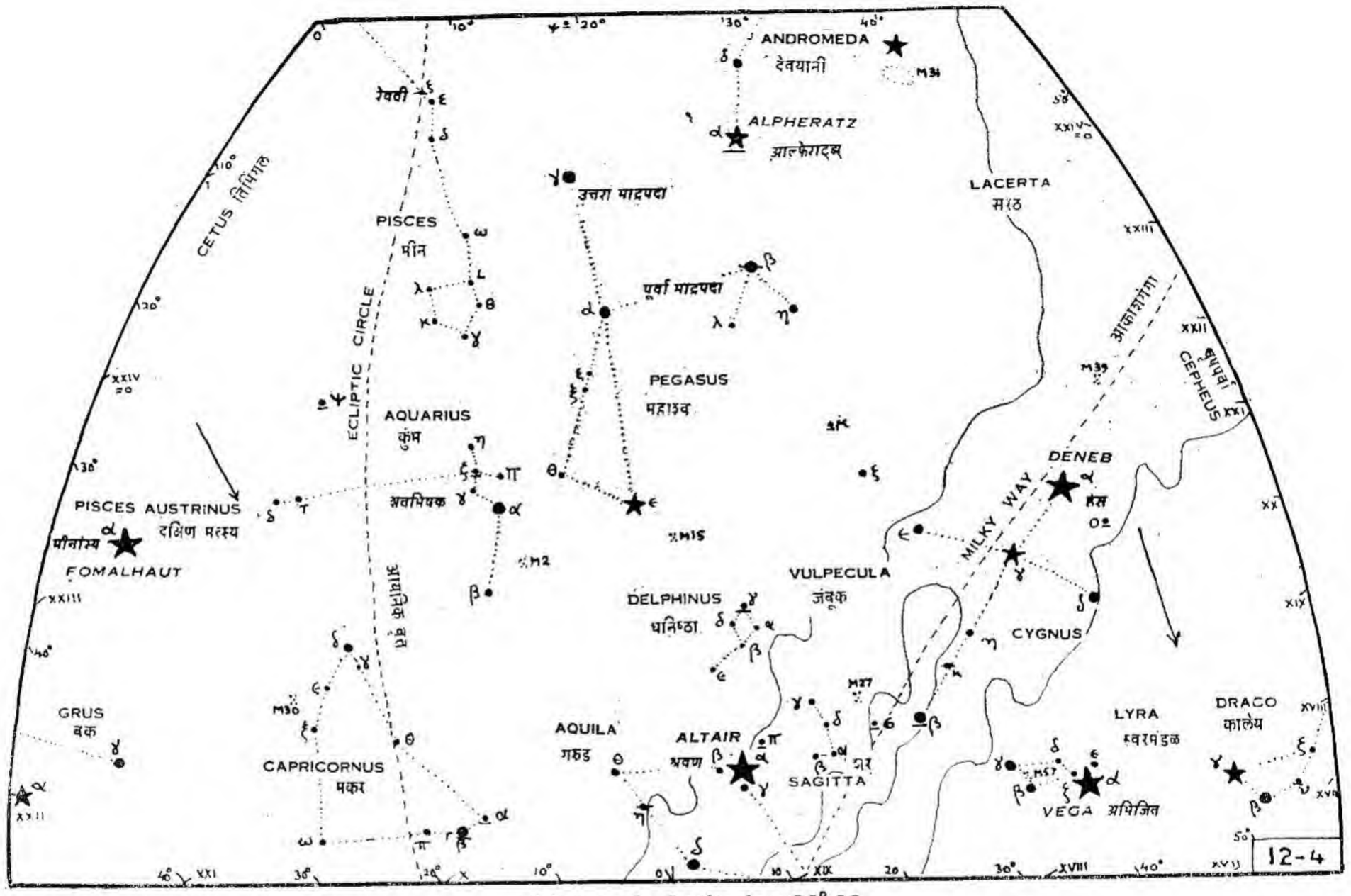

Observer's Latitude : 25° N

DECEMBER
WEST
KEY-MAP

August	1 at 5 a. m. (I. S. T.)	August	15 at 4 a. m. (I. S. T.)
September	1 at 3 a. m.	September	15 at 2 a. m.
November	1 at 11 p. m.	November	15 at 10 p. m.
December	**1 at 9 p. m.**	**December**	**15 at 8 p. m.**
January	1 at 7 p. m.	January	15 at 6 p. m.

DECEMBER : WESTERN SKY

Prominent Stars :

- α in Andromeda (Alpheratz).
- α in Aquarius (Sad-al-Malik).
- α in Aquila (Altair).
- α in Capricornus (Giedi).
- α and β in Cygnus (Deneb and Albireo).
- α in Lyra (Vega).
- α and β in Pegasus (Markab and Sheat).
- α in Pisces Austrinus (Formalhaut).

Double Stars :

- ψ in Aquarius, nice double, seen with field-glasses.
- ζ in Aquarius, seen with a 7.5 or 10cm. telescope.
- β, μ, o_2 in Cygnus, seen with field glasses.
  o_2 in Cygnus itself is a triplet.
- γ in Delphinus, yellow and emerald, seen with a 5 cm. telescope.
- ψ_1, ζ in Pisces, easily resolvable doubles.
- α in Pisces, for large telescope only.

Nebulae and Star Clusters :

- M 31 (INGC 224) in Andromeda near ν, long and hazy, visible to naked eyes, extragalactic and receding.
  Distance = 2,200,000 light-years.
- M 2 (NGC 7089) in Aquarius near β, seen with naked eyes.
- M 30 (NGC 7099) in Capricornus, near ζ, globular, seen with a field-glass.
- M 39 (NGC 7092) in Cygnus beyond α and near π^2. Open cluster, seen with field-glasses. There is a strong source of radio emission
- M 15 (NGC 7078) in Pegasus near ε. Globular and brilliant.

* * *

Neutron Stars

ABOUT TWENTY or so stars are quite bright and attract our attention on any clear night. With the naked eye, however, we are able to see in all a few thousand stars down to the visual limit of faintness. The telescope helps us to see thousands and thousands of stars which are far beyond this limit of visual perception and, in conjunction with the photographic plate, can record still larger number of fainter stars and thus discloses their existence in the heavens. These are, of course, our usual common methods whic rely upon the light emitted by the distant stars and are termed as the optical methods. When the Radio telescope,* using the radio-frequency waves emitted by the heavenly objects, was invented, our limits of perception were at once widened considerably. Astronomical objects emitting radio waves came to be located without our being able to see them visually. It has further, become possible to locate stellar objects which emit X-rays, by using appropriate instrumentation carried high up outside the earth's atmosphere by rockets and artificial satellites.

The first X-ray emitting star was located in 1966 in the constellation Scorpius in the southern part of the Milky Way. It is a 13th. magnitude blue variable star.** The peculiarity of this star is that it emits 1000 times more energy in the X-ray region than in the visible part of the electromagnetic spectrum. This is quite unexpected of any variable star studied so far from our ground-based stations. In fact, its-X-ray emission was found to be qual to the total energy output of the Sun at all wave-lengths. This strange X-ray source that remained naturally unnoticed so far, especially because it lakced both visible and the radio-freqency emissions.

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* see *Radio telescope* page 211

** see *Variable Stars* page 171

(Continued on page 254 column 1)

Observer's Latitude : 25°N

DECEMBER ZENITH NIGHT - SKY

August	1	at	5	a. m. (I. S. T.)	August	15	at	4	a. m. (J. S. T.)
September	1	at	3	a. m.	September	15	at	2	a. m.
November	1	at	11	p. m.	November	15	at	10	p. m.
December	**1**	**at**	**9**	**p. m.**	**December**	**15**	**at**	**8**	**p. m.**
January	1	at	7	p. m.	January	15	at	6	p. m.

Camelopardalis

CAMELOPARDALIS MEANS the Giraffe. It is a constellation in the northern sky and it lies between Auriga and Cassiopeia. It has many faint stars and is stretched out to reach even beyond the Pole Star. There is no star brighter than magnitude 4. (See Fig. 12.6).

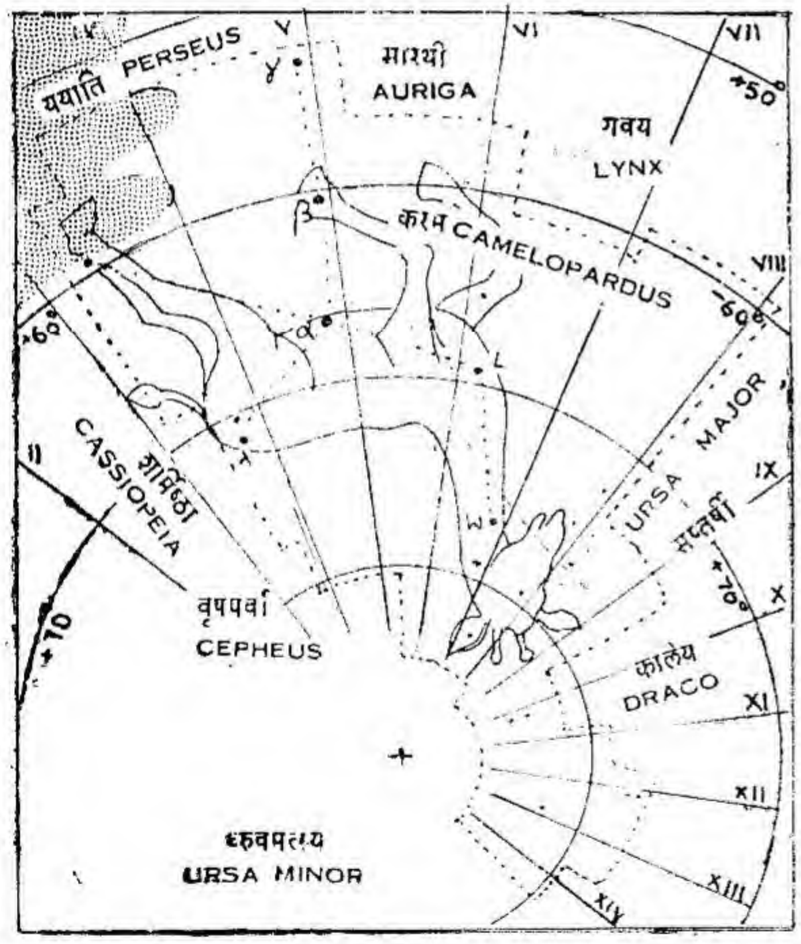

Fig. 12.6 : Camelopardalis

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Caelum

CAELUM MEANS the Sculptor's Chisel. It is an inconspicuous constellation in the southern sky situated to the south of Taurus and between Columba and Eridanus. (See Fig. 12.7).

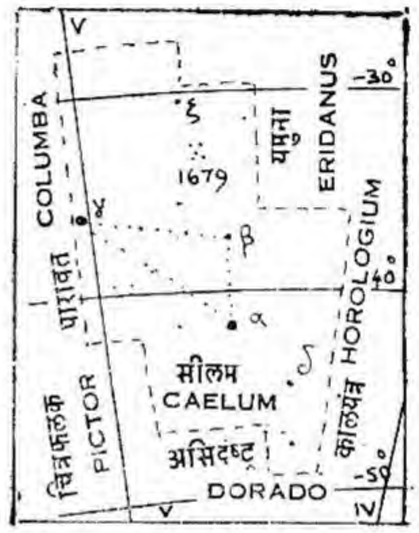

Fig. 12.7 : Caelum,

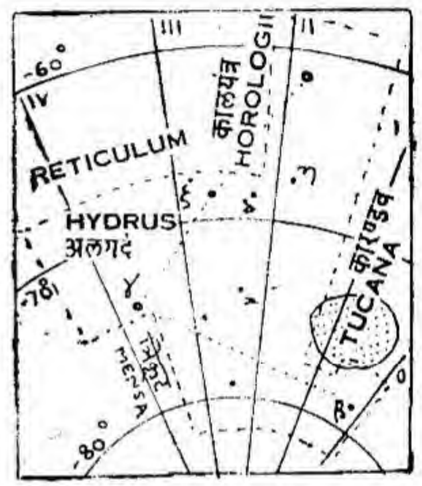

Fig. 12.8 : Hydrus

Hydrus

THE CONSTELLATION lies to the south of Eridanus and it looks like an equilateral triangle with 3 corner stars of magnitude 3. When one side of the triangle is prolonged towards the north it meets the bright star Achernar (α of Eridanus). Almost half of this constellation remains invisible to us, but it is interesting to note that α of Hydrus was in the position of the South Celestial Pole Star when α of Draco (Thuban) was the North Pole Star about 2,700 B. C. (See Fig. 12.8).

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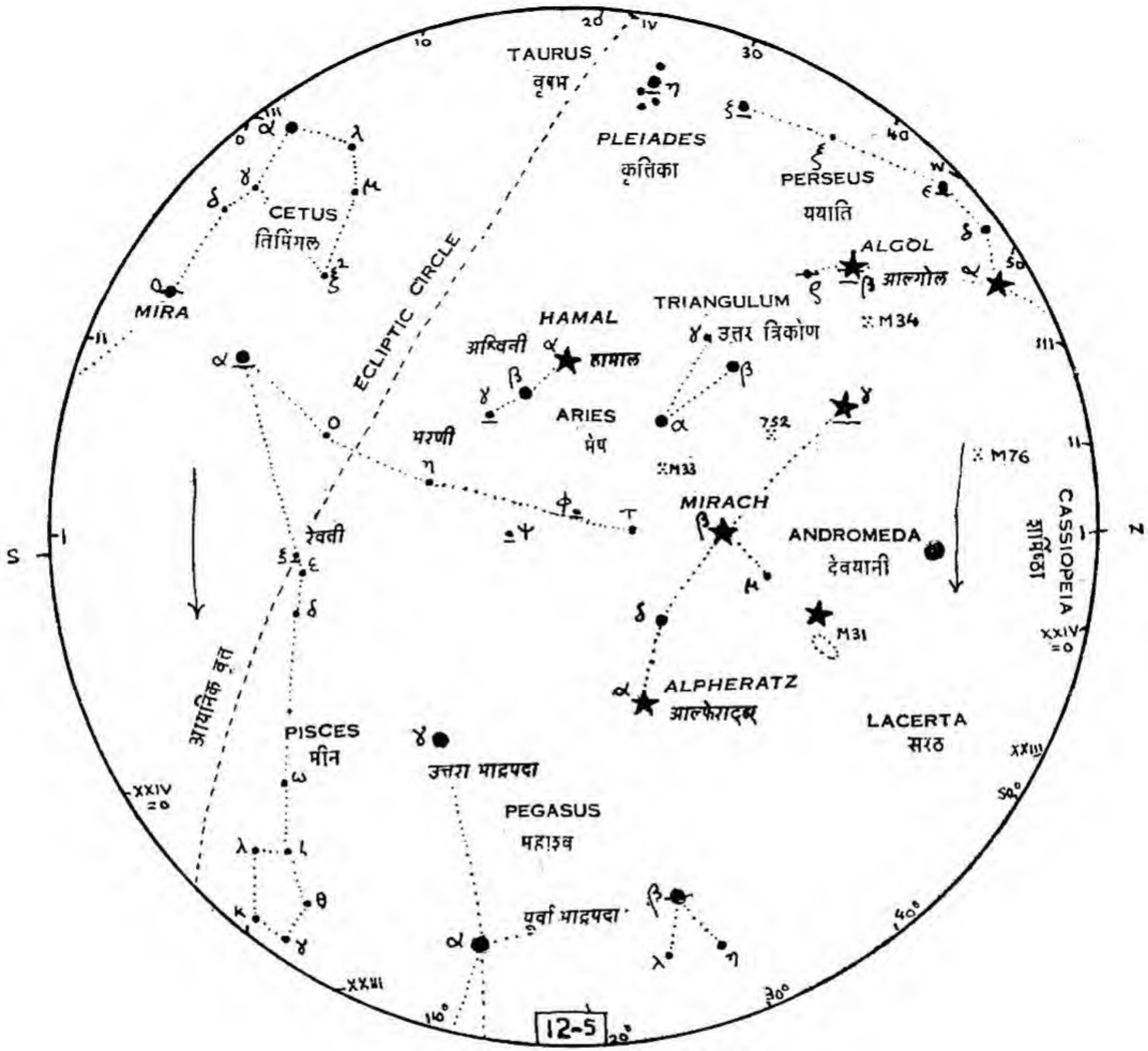

Observer's Latitude : 25°N

DECEMBER ZENITH KEY-MAP

August	1 at 5 a. m. (I. S. T.)	August	15 at 4 a. m. (I. S. T.)
September	1 at 3 a. m.	September	15 at 2 a. m.
November	1 at 11 p. m.	November	15 at 10 p. m.
December	**1 at 9 p. m.**	**December**	**15 at 8 p. m**
January	1 at 7 p. m.	January	15 at 6 b. m.

Columba

COLUMBA, MEANING the Dove, is a southern constellation and this nomenclature is modern. It lies on the line joining Rigel (β of Orion) and Canopus (α of Carina). There are only two stars of magnitude 3. The others are faint. The star α of Columba is known as Phakt. According to Norman Lockeyor, the British Astronomer, the bright star α of Columba was known to ancient Egyptians and they appear to have given it the same importance as they gave to Thuban (α of Draco), the former Pole Star. Temples built in the period, 2525 B.C., 1250 B.C. and 900 B. C. were so constructed as to admit observation of this star from the temple's innermost premises. In other words, windows and doors of these temples were so oriented as to allow light from this star to fall on the images of Gods inside the temples. (See Fig. 12.9).

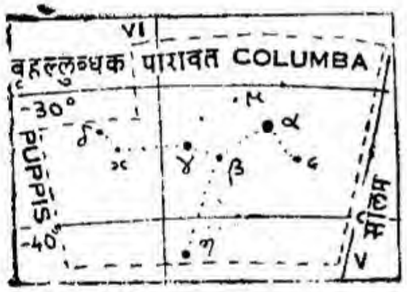

Fig. 12.9 : Columba

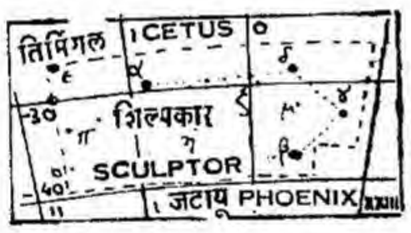

Fig. 12.10 : Sculptor

Sculptor

THE NOMENCLATURE is modern and the constellation is situated in the Southern Hemisphere, occupying an inconspicuous part of the sky where no bright stars are seen.

Sculptor is to the south of Cetus and Aquarius. The south Pole of our galaxy, the Milky Way, lies in this constellation. When we look at Sculptor, we do so in a direction perpendicular to the galactic plane and therefore through a relatively thin disk of stars. This fact accounts for the absence of any bright stars in the area. (See Fig. 12.10).

* * *

Fornax

THE NAME is modern and it means a Celestial Furnace. The constellation lies to the south of Cetus and it contains no star brighter than of magnitude 4. (See Fig. 12.10).

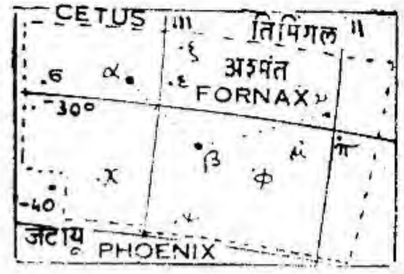

Fig. 12.11 - Fornax.

* * *

Horologium

HOROLOGIUM MEANS the Clock. It is another inconspicuous constellation in the southern sky with only one bright star of magnitude 3.8. The name of this star is Lucida. The constellation lies between the four-sided figure of Lepus and the star Achernar of Eridanus. (See Fig. 12.12).

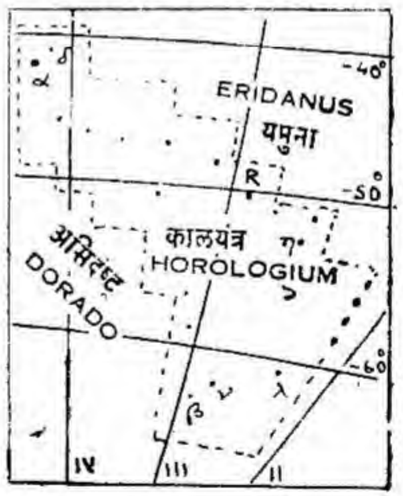

Fig. 12.12 : Horologium

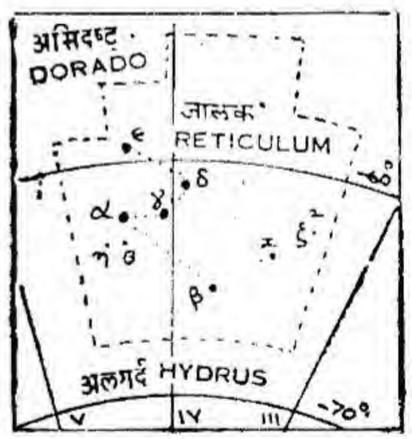

Fig. 12.13 : Hydrus

Reticulum

RETICULUM MEANS the Net. This is an inconspicuous constellation of the southern sky. It is rhomboidal in shape and contains two bright stars, one of magnitde 3 is yellow, and one of magnitude 4 is orange. The constellation lies between Hydrus, Horologium and Dorado. (See Fig. 12.13).

* * *

(Continued from page 249 column 2)

Neutron Stars

Immediately after the discovery of the neutrons, two famous astronomers, Bade and Zwicky of the Mount Wilson observatory, had proposed in 1934 the possibility of the existence of such a body and had named it a Neutron Star. The details of its theoretical structure and evolution were later worked out by famous nuclear physicists Oppenheimer and Volkoff. According to their concept, a neutron star is what remains after gravitational collapse of a large star due to depletion of its inernal source of energy. A Neutron Star would contain almost as much mass as the Sun (viz. 2×10^{30} Kg.) compressed into a sphere of roughly 16 Km. in diameter. It is a super-dense state of matter consisting almost entirely of neutrons. The density at its centre would be about 100 million times the density of the core of a compact white dwarf star.

The surface temperature of a Neutron Star would be about 10 million degrees Kelvin and of the innermost core as high as 6 billion degrees Kelvin. Because of these high temperatures a Neutron Star would emit about 10 billion times more energy in the form of X-rays than in the form of visible light. This has been found to be so in the case of an X-ray source in Scorpious as also that in Crab Nebula.

To understand how X-rays could be produced in a Neutron Star, it would be useful to consider the evolution of such a star. A star is supported against the inward force of gravitation by the internal pressure maintained by its high central temperature. If this vital balance is disturbed, the star quickly adjusts itself to a new equilibrium by either shrinking or expanding. Even at the centre of the Sun, where the density is seven times that of lead (about 80 gms per cubic centimeter), the behaviour of the gas never departs from the ideal gas-law (Pressure is proportional to the density times temperature). Inside a white dwarf star, however, temperatures, are not significantly higher than they are inside the Sun, (almost 13 million degrees), yet the density often reaches several thousand kilograms per cubic centimeter. As a result of this, the ideal gas-law breaks down inside a White Dwarf Star.

A. S. Eddington had already suggested, in 1924, that such high density of a white dwarf star could only be explained by supposing that the atoms in the core were completely stripped of their electrons. It is this state that enables the bare nuclei to pack themselves so tightly together. The sheer squashing of material would produce the conditions known as 'electron degeneracy'. In this state, although the nuclei themselves would continue to follow the ideal gas-laws, the degenerate electrons would now produce a pressure so much higher than the nuclear gas pressure that the latter would be considerep negligible in comparison.

If the density of a white dwarf star were increased 100,000 fold even the nucleus (i. e. neutrons, protons and electrons) would be compressed to the point at which they would begin to touch each other. This condition of neucleon degeneracy must exist in a neutron star.

A star ages in successive stages, first, burning hydrogen to form helium, then, helium to form carbon, carbon to form oxygen, neon and magnesium, mangesium to from sulphur to form iron***. The duration and the various stages of burning may be as long as 10 million years (from hydrogen to helium) or as short as one year (from sulphur to iron). As each stage reaches its and, a period of gravitational collapse ensues. These contraction periods may last 10 to 1000, 000 years, depending on the mass of the star. The energy derived from each contraction raises the temperature of the core until the next stage of nuclear synthesis is ignited. Temperatures range from a low of 10 million degrees for the fusion of hydrogen upto about 5 billion degrees for the conversion of sulphur to iron. At lower temperature levels, surplus energy is dissipated in the form of visible light quanta or protons. At higher temperature levels, the protons are converted into neutrons with consequent emission of neutrons.

*** *Nuclear reactions* see page 244.

* * *

Microcosm and Macrocosm

THESE WORDS are now becoming common in ordinary language. They are derived from three Greek words; *micro* meaning small *macro* meaning large and *kosmos* meaning the universe. Studies in atomic physics and radio-astronomy have largerly contributed to our knowledge of the sizes of very small and very large objects and forms. It is usual to indicate the size in terms of linear dimensions, namely, length, breadth and height. The linear dimension is one which is most easily understood by man in terms of lengths or distances.

The known universe extends from lengths as small as one millionth of a milli-micron ($=10^{-18}$ Km.) to lengths and distance as large as one hundred thousand million light-years ($=10^{24}$ Km.) While attempting to express the sizes of the microcosm and the macrocosm, it would be appropriate to give some well-known illustrations of smallest and largest objects and forms known to us.

1) 1/1,000,000 millimicron $=10^{-18}$ Km. $=$ 10^{-12} mm.

This is almost the size of an atomic nucleus.

2) 1/10,000 millimicron $=10^{-16}$ Km. $=$ 10^{-10} mm.

The nucleus of atom $\sim 10^{-12}$ mm.

3) 1/100 millimicron $=$ 10^{-14} Km. $=10^{-8}$ mm.

The size of an atom with its nucleus and the surrounding electronic orbits $\sim$ 10^{-8} mm.

4) 1 millimicron $=$ 10^{-12} Km. $=10^{-6}$ mm.

A molecule of methane containing one carbon atom and four hydrogen atoms has a diameter nearly equal to 0.2 mill micron $=0.2\times10^{-6}$ mm.

5) 1/10 micron $=10^{-10}$ Km. $=$ 10^{-4} mm.

The size of an influenza bacillus is of the order of 0.0012 mm $\sim$ 10^{-4} mm.

6) 10 microns $=$ 10^{-8} Km. $=10^{-2}$ mm.

The diameter of a red blood corpuscle is of the order of 10 microns.

7) 1 mm. $=10^{-6}$ Km.

Small star-shaped, one-cell sea-creatures known as *Radilaria* have length or breadth of the order of 1 millimetre.

8) 10 cms. $=$ 10^{-4} Km.

The average length of a domestic lizard is about 15 cms.

9) 10 metres $=$ 10^{-2} Km.

The height of a common building with ground and two floors is generally 10 meters.

10) 1 Km.

This is a very familiar measure of distance which we know in terms of miles, furlongs and yards.

11) 10^{2} Km.

Distance between Delhi and Agra is 174 Km.

12) 10^{4} Km

Diameter of the Earth $=$ 12,757 Km.

13) 10^{6} Km. $=3.3$ light-seconds.

Diameter of the Sun $=1$, 392,000 Km.
(Light-year, light-hours, light-minute of light-second is a measure of the distance which light, with the its velocity of 3×10^{10} cm/sec would travel. in a year, hour. minute or second respectively).

14) 10^8 Km.= 6 light-minutes

The diameter of the star β (Sheat) of Pegasus is nearly equal to 2.5 light minutes.

15) 10^{10} Km.= 10 light-hours.

The dark companion of the double star ε of Auriga is approximately 6 light-hours in diameter.

16) 12^{12} Km = 0.1 light-year.

Distance between the star α of Centaurus and Star Proxima of Centaurus is about 0.15 light-year.

(Star Proxima is binary with the star α of Centaurus which itself consists of two components. The period of revolution of Proxima around α is about 1 million years).

17) 10^{14} Km = 10 light-yera.

The star Sirius (α of Canis Major) and the star α of Centaurus are neighbours in a sphere of radius equal to 10 light-years, with the Sun at its ce tre.

18) 10^{16} Km. = 1,000 light-years.

The globular star-cluster M 92 (NGC 6431) in Hercules has a diameter of 300 light-years.

19) 10^{18} Km.=100,000 light-years.

This is approximately the expanse of the Milky Way.

20) 10^{20} Km.=10,000,000 light-years.

A cluster of external galaxies observed in the constellation Pisces has an expanse of this order.

21) 10^{22} Km. =1,000 million light-years.

Radius of the universe perceptible with the largest telescope is of this order.

22) 10^{24} Km. = 100,000 million light-years.

The part of the Cosmos that is perceptible with radio-telescopes is of this order.

As we proceed from the microcosm to the macrocosm each form is succeeded by a new phenomenon which in turn is reduced to comparative nothingness.

If the Universe extends to infinity in all directions, we can imagine the space to be infinite. But some theoreticians favour the idea of regarding the Universe as finite. According to this notion the Universe would have a fixed and perhaps even 'measurable' volume. Space could then be 'curved' and unlimited in the same way that, for instance, the surface of a sphere is bounded and has no limits. This kind of spaces, however, is a mathematical abstraction and it is impossible to have any mental picture of it.

* * *

Pulsating Stars

THERE ARE some stars in which the variation of brightness is believd to be caused by expansion and subsequent contraction of the stellar body. Such stars are called Pulsating Stars. Cepheids and star β in Canis Major are good examples of Pulsating stars.

* * *

Star Names & Their Meanings*

ANDROMEDA DEVAYĀNĪ

Alpheratz. Sirrah.
(Early Arabic : Al Surrat al Faras= The horse's head (Pegasus)
Late Arabic : Al Ras al Mar'ah al Musalsalah
=The Head of the Woman in Chains

β **Mirach** Mi'zar= Girdle or Waist Cloth, *Purvā Bhādrapadā*

γ **Alamac**=A small predatery animal of Arabia (Badger)
Al ' Anāk al ' Ard
Late Arabic=Al Rij al Musalsalah
=The Woman's foot *Uttarā Bhādrapadā*

ξ **Adhil** : Al Dhail=The Train of a Garment

AQUARIUS KUMBHA

α **Sadalmalik** Al Sa'd al Malik/Mulk
=The Lucky One of the King (Kingdom)

β **Sadalsuud** : Sa'd al Su'ud=Luckiest of the Lucky

γ **Sadalchibia** : Al Sa'd al Ah'biyah=The Lucky Star of Hidden Things or Hiding Places

δ **Skat** Al Shi'at=A Wish
Also Al Ṣāk=The Shin Bone

AQUILA GARŪDA

α **Altair** : Arabic Althair, Athair, Attair, Atair, *Śravaṇa*
Atair=(Ref. Ben Hur) Name of one of the Shaykh Ilderim' Horses in the Chariot Race of Antioch
Euphratean Idxu= Eagle, Erigu= Powerful Bird

β **Alshain** Shahin=A portion of the Persian name for the Constellation Al Uṇuḳ al Ghurāb=The Raven's Neck.

γ **Terazad** (Persian)
The group δ, η, θ were Al Mīzān=The Scale Beam (Arabic).

ARIES MEṢA

α **Hamal** Al Rās al Ḥamal=The Head of the Sheep *Aśvinī*

β **Sharatan** Sheratan from Al Sharaṭain

γ **Mesarim** Arabic Athāfiyy=Trivets or Tripods (Three stones forming a kitchen)

δ **Boain** : Al Buṭain, dual of Al Baṭn=The Belly

AURIGA SĀRATHĪ

α **Capella** (Greek) The little She Goat, *Brahma Hṛdaya*
Arabic Al Rākib=The Driver

β **Menkalinan** Al Mankib dhi'l Inān=The shoulder of the Rein Holder *Agni*

γ Al Ḳa'b dhi'l Inān=The Heel of the Rein holder

ε Al Ma'az=The He-goat

BOÖTES BHŪTAPA

α **Arcturus** Al Simāk' al Rāmiḥ=The Leg of the Lance-Bearer
=The Lofty Lance-bearer in Ṛgveda, Āryamān Swati

β **Nekkar** Nakkar, Arabic name of the whole constellation

γ, δ, μ This group made a trapezium
Al Dhi'bah=The Female Wolves Hyaenas

η **Mufrid** : Muphrid Al Mufrid al Rāmiḥ
=The solitary Star of the Lancer

μ **Alkalurops** Herdsman's Club, Crook, Staff

CANCER KARKA

α **Acubens** Al Zubanāh The Claws *Puṣya*
This pair was called in Latin Asini=Donkeys

γ, δ in Arabic Al Ḥimārain=The Two Asses

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* Based on the book : "Star Names, their Lore and Meanings" by R. H. Allen and Published by Dover Publication Inc. New York, 1963.

CANES VENATICI ŚYAMA ŚABLA

α Cor Caroli Charles's Heart

CANIS MAJOR BṚHALLUBDHAKA

Vyādhha

α **Sirius** The Dog Star
modern Arabic Suhail
=Genral designation of a bright star.
(arabic) Barāiaḳh=of a thousand colours

β **Murzim** Mirzam, Al Murzim=The Announcer

δ **Wezen** Al Wazn= Weight (The Star seems to rise with great difficulty from the horizon)

ε **Adhara** Al Adhārā=The Virgins,
in connection with the Arabic story of Suhail

η **ALUDRA** Al 'Adhrā singular of Al Adhārā and one of the group

CANIS MINOR LAGHU LUBDHAKA

Prasvā

α Procyon, Precursor of the Dog.
(Arabic) Al Shi'rā' al Shāmiyyah or Al Shāmiyyah

β **Gomeisa** Al Gamus, Al Murzim as if announcing the rising of the brightest star (Sirius)

CAPRICORNUS MAKARA

α **Gidi** Al Jady or Algedi=The Goat

γ **Nashira** Al Sa'd al Nashirah
=The Fortunate One or The Bringer of Things

δ **Deneb Algedi** Al Dhanab al Jady=Tail of the Goat

CARINA NAUKĀ TALA

α **Canopus** (Greek), Kanupus is an arabic adaptation of the great name *Agastya*

CASSIOPEIA ŚARMIṢṬHĀ

Shadar Al Sadr=The Breast

Caph Al Sanām al Nākah=The Camel's Hump,
Queen's Heart, The Tinted Hand

Cih (Chineese) Taih=Whip

Ruckbah Al Rukbah=The Knee

CENTAURUS NARATURAGA

α **Al Kentarus** Al Rijl al Kentaurus=The Centaur's Foot *Mitra*

β **Mah Fuh** (Chineese)=The Horse's Belly *Mitraka*

CEPHEUS VṚṢAPARVA

α **Al deramin** Al Dhirā al Yamīn=The Right Arm

β **Alfirk**

γ **Al Rai** Al Rā'i'=The Shepherd

ξ (Chineese) Hwa Kee = The State Umbrella

CETUS TIMIṄGALA

α Menkar Al Minḥer, The Nose (now it marks the Jaw)

β **Deneb Kaitos** Al Dhanab al aiṭos al Ḳjanūbīyy
(Difda) Al Difdi al Thānī=the second frog=The tail of the Whale

o **Mira** Wonderful Star, *Timiṅgala*

ζ **Baten Kaitos**=Al Baṭn al Ḳaiṭos The Whale's Belly

COMA BERENICES ARUNDHATĪ KEŚA

CORONA BOREALIS UTTARA MUKUTA

α **Gemma**=The Crown Jewel- *Mukutamaṇi*
(Arabic) Al Nair al Fakkah The Bright one of the Dish

CORVUS HATTA

α **Al Chiba** Al Minḥar al Ghurāb = The Raven's Beak

β *Aṅgustha*

γ **Gienah** Al Janāh al Churāb al Aiman
= Right Wing of the Raven *Madhyamā*

δ **Al Ghorab**

CRATER CAṢAKA

α **Alkes** Al Kās = A shallow Basin

CRUX TRIŚAṄKU

α A crux = Alpha crusis

CYGNUS HAMSA

α **Deneb** Al Dhanab al Dajājah
= The Hen's Tail (which became Deneb Adige) *Haṁsa*

β **Albireo** Al Minhar al Dajājah = The Hen's beak

γ **Sadr** Al Sadr al Dajājah = The Hen's Breast

ε **Gienah** Al Janah = The Wing.

π **Azelfalage** (Al Thīlf al Faras = The Horses's Foot or Track)
Arabic Al 'Azal al Dajājah = The Tail of the Hen.

ω² **Ruchba** Al Rukbah al Dajājah = The Hen's Knee

DRACO KĀLEYA

ω **Thuban** Al Tinnin is Arabic for the whole Draco

β **Rastaben** Al Rās al Thu'bān = The Dragon's Head
Early Arabs called it Al 'Awāid = The Mother Camels

γ **Etamin, Eltanin** Etamin Al Rās al Tinnīn = The Dragon's Head

ERIDANUS YAMUNĀ

α **Achernar** Al Āḥir al Nāhr = The End of the River

β **Cursa** Al Kursiyy al Jauzah = The chair of the Central One.

γ **Zaurac** Zaurak Al Nāir al Zaurak = The Bright Star of the Boat.

GEMINI MITHUNA

α **Castor** Al Rās al Taum al Mukaddim
= Head of he Foremost Twin *Punarvasu*

β **Pollux** Al Rās al Taum al Mu'ahhār = Head of the Hindmost Twin

γ **Allen'ah** *Ārdrā*

δ **Wasat**

ε **Mebsuta**

HERCULES ŚAURĪ

α **Ras Alghetti** Rās Al Ras al Jāthiyy = The Kneeler's Head

β **Korneforos**, or Kornephoros

χ **Masym** Mi'ṣam = The Wrist

HYDRA VĀSUKĪ

α **Alphard** Al Farad al Shujā' = The Solitary One in the Serpent

LEO SIMHA

α **Regulus** (Arabic) Malikiyy = Kingly *Maghā*

β **Denebola** (abbrev.) of Al Dhanab al Asad = the Lion's Tail

γ **Algieba** Algeiba (Latin) Juba = The Lions Mane
Algeibais from the Latin,
Arabicized either by error in transcription or by design

δ **Zosma** Zozma Al Ṭhahr al Asad = The Lion's Back (rump)

ε **Algenubi** Al Rās al Asad al Janūbiyyah
= Southern Star in the Lion's Head

LEPUS ŚAŚAKA

π **Arneb** Arabic name for the whole constellation

LIBRA — TULA

(Arabic astronomers, following Ptolemy, knew these stars as Al Zubānā=the Claws. Later, influenced by Rome, these stars became Al Kiffatān=The Trays of the Balance.)

α **Zubenelgenubi** Al Zubān al Janūbiyyah is Arabic equialent of Ptolemy's term. Roman : Al Kiffah al Janūbiyyah = The Southern Tray of the Scale. *Viśākhā*

Al Mīzān=The Scale Beam

β **Zubenelchameli** Zuben al Chameli
(Arabic) Al Zubān al Shamāliyyah = The Northern Claw

δ **Mulu-izi**

η **Zubenalhakrabi**

LYRA — SVARA MAṆDALA

α **Vega** (Wega) Arabian Wākī' *Abhijit*

β **Sheliak** Al Shilyāk=one Arabian name of the Lyra

γ **Sulafat** Title for the whole constellation.

OPHIUCHUS — BHUJAṄGA DHĀRĪ

α **Ras alhague** Rās al Hawwā = The Head of the Serpent Charmer

β **Cebalrai** Kalb al Ra'i=The Heart of the Shephard

γ **Muliphan**

δ **Yed Prior**=The Former of the two Stars in the Hand. Yad is Arabic

ε **Yad Posterior** The Star Behind, or Following

η **Sabik,** Sābik=Sāik the Driver

λ **Marfic,** Marfik, Al Marfik=The Elbow

ORION — MṚGA

α **Betelgeuse** Ibṭ al Jauzah=The Armpit of the Central One
Al Mankib=The Shoulder
Al Dhira'=The Arm
Al Yad al Yamna'=The Right Hand

β **Rigel** Rijl Jauzah al Yusrā'=The Left Leg of Jauzah

γ **Bellatrix** The Female Warrior
Al Murzim al Najīd=The Roaring Conqueror

δ **Mintaka** Al Minṭakah=The Belt

ε **Alnilam** Al Niṭhām=The String of Pearls

ζ **Alnitak** Al Niṭak=The Girdle

η **Saiph** Saif Al Jabbār=The Sword of the Giant

PEGASUB — MAHĀŚVA

α **Markab** (Arabic) Marchab= Saddle, Ship, or Vehicle
(Anything ridden upon) *Pūrvā Bhadrapadā*

β **Scheat** Al Sā'id=Upper Part o the Arm
Arabic Astronomers called it Mankib al Faras=Horse's Shoulder

γ **Albdnib** Al Janāh=The Wing. *Uttarā Bhadrapadā*

ε **Enif** Enf. Enir from Al Anf=The Nose

ζ **Homan** Sá'd al Humām=The Star of the Hero

PERSUES — YAYĀTI

α (**Algenib**) Al Janb=The Side
Miriak or Marfak Mirzac or Marfik al Thurayya=The Elbow

β **Algol** Rās al Ghūl=The Demon's Head

ξ **Mankib** Mankib al Thurayya=The Shoulder of Thurayya

PISCES — MĪNA

α **Al Recha or Al Risha**= Al Rishā' = The Cord
=Kaitain in Arabic Ukd=al Haitain or Al Haiṭ al Kattaniyy
=The Flaxen Thread

PISCES AUSTRUNUS DAKṢINA MATSYA

α **Fomalhaut** Fum al Ḥūt = The Fish's mouth *Mīnasya*

SAGITTARIUS DHANU

α **Rukbat** also Rucha, Rucbah, Rukbah
from Arabic Rukbat al Rāmī = The Archer's Knee

β **Arkab** Urkab Al ʻUrkūb = The Tendon uniting the Calf of the Leg to the Heel

γ **Al Nasl** Al Naṣl = The Point. Head of the Arrow.

SCORPIUS VṚŚCIKA

α **Antares** (arabic) Antar = Shone *Joeṣṭha*
Arabic Kalb al ʻAkrab = The Scorpion's Heart

β **Akrab** Aakrab achemali
Iklīl al Jabhah = The Crown of the Forehead

γ **Zubān al ʻAkrab** The Scorpion's Claw

δ **Dschubba** Al Jabhah = The Front of the Forehead
(Arabic) Iklīl al ʻAkrab = The Crown of the Scorpion.

λ **Shaula** Al Shaulah = The Sting

SERPENS BHUJAṄGA

α **Unuk al Hay** ʻUnk al Ḥayyah = The Neck of the Snake

TAURUS VṚṢABHA

α **Aldebaran** Al Dabarān = The Follower *Rohiṇī*

β **El Nath** Al Nāṭiḥ = The Butting One, because located on the tip of the Northern Horn (*Pleiades*)

η **Alcyone** Arabs called it Al Jauz = The Walnut *Kṛittikā*
Al Jauzah or Al Wasaṭ = The Central One
Al N'air = The Bright One

23 **Merope** The name itself signifies 'Mortal'

URSA MAJOR SAPTARṢI

α **Dubhe** the Bear, *Kratu*
Ṭhahar al Dubb al Akbar = The Back of the Greater Bear

β **Merak** Al Merākk = The Loin of the Bear, *Pulaha*

γ **Phacd** Phekde Al Fahidh = The Thigh, *Pulasya*

δ **Megrez** Al Megrez = The Root of the Tail, *Atri*

ε **Alioth** Alyat = The Fat Tail (of the Eastern Sheep) *Aṅgirā*

ζ **Mizar** Mirak Mi'zar = Girdle *Vasiṣtha*

η **Alkaid** Kā'id Banāt al Naash *Marīci*
= The Chief of the Mourners

URSA MINOR DHRUVA MATSYA

α **Polaris** (Arabian) Al Kiblah because of its least distance from the Pole *Dhruva Tara*

β **Kochab** is from the Arabic title that it shared with α Polaris

VIRGO KANYĀ

α **Spica** The early Wheat *Citrā*
(Arabic) Al Hulbah = The Bristle

β **Zavijava** Al Zāwiah = Angle, Corner, Kennel

γ **Porrima** Zāwiat al ʻAwwa' = The Angle or the Corner of the Barker

* * *

Map 1 showing Constellations and their representative but imaginary Figures Around the North Celestial Pole (anti-clockwise).

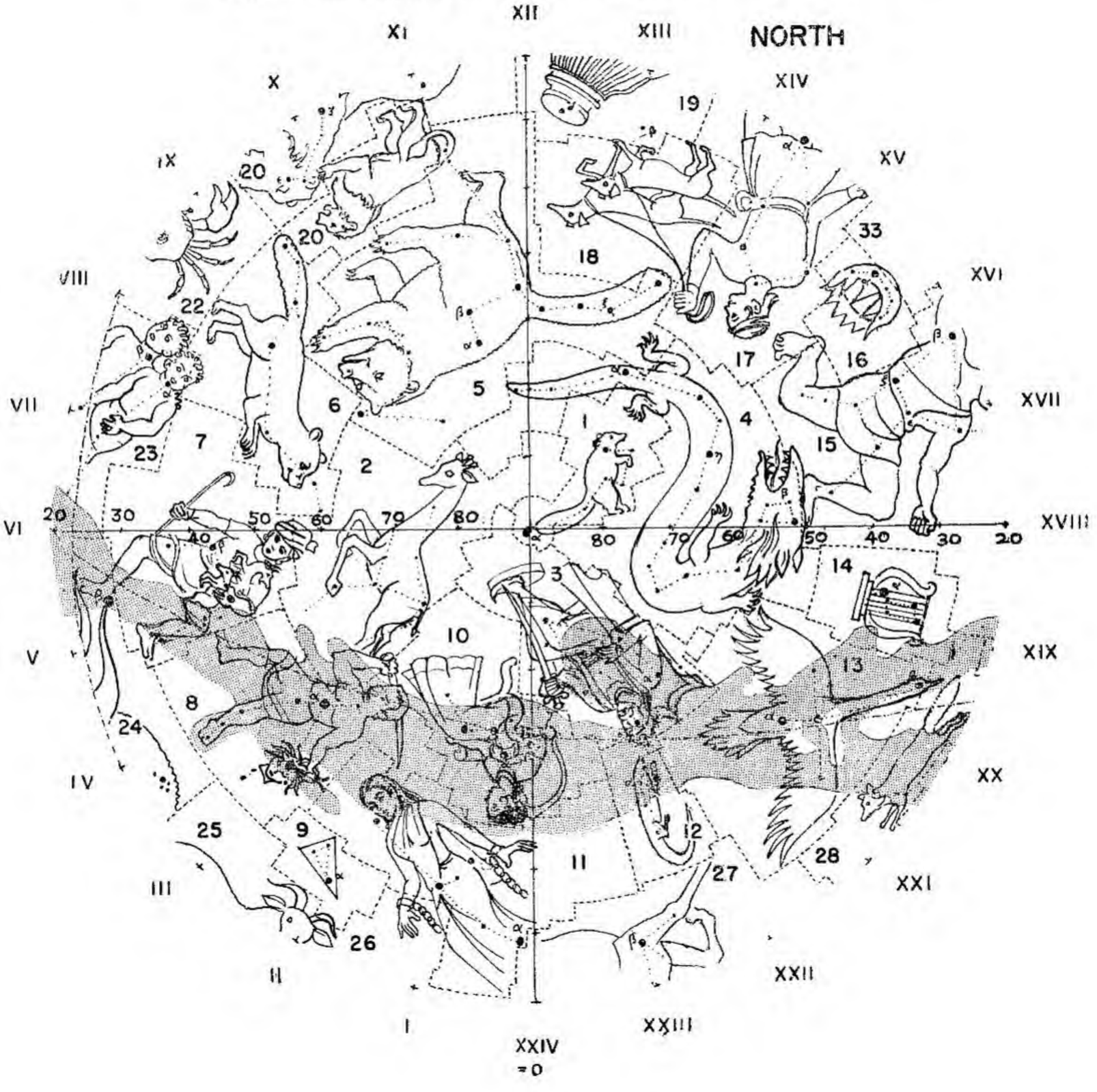

Table 1 showing, with reference to the Map 1, International Names of Constellations, their Indian and English equivalents along with some prominent features.

Sr. No.	International name	English name	Indian name	Prominent features
1	Ursa Minor	Little Bear	Dhruva Matsya	Polaris
2	Camelopardus	Giraffe	Karabha	
3	Cepheus	Cepheus	Viṣaparvā	
4	Draco	Dragon	Kāleya	Thuban
5	Ursa Major	Great Bear	Saptarṣī	Dubhe, Mizar
6	Lynx	Lynx	Gavaya	
7	Auriga	Charioteer	Sārathi	Capella
8	Perseus	Perseus	Yayātī	Algol
9	Triangulum Borealis	Triangle (northern)	Uttara Trikoṇa	M 33
10	Cassiopeia	Cassiopeia	Śarmiṣṭhā	Shedar
11	Andromeda	Andromeda	Devayānī	Alpheratz, Mirach, M 31
12	Lacerta	Lizard	Saraṭha	
13	Cygnus	Swan	Hamsa	Deneb
14	Lyra	Lyra	Svara Maṇdala	Vega, M 57
15	Hercules	Hercules	Śaurī	Ras al Ghetti, M 13
16	Corona Borealis	Northern Crown	Uttara Mukuta	Gemma
17	Boötes	Herdsman	Bhūtapa	Arcturus
18	Canes Venatici	Hunting Dogs	Śyama-śabala	Cor Caroli, M 57
19	Coma Berenices	Berenices Hair	Arundhatī Keśa	
20	Leo Minor	Little Lion	Laghu Simha	
21	Leo	Lion	Simha	Regulus, Denebola
22	Cancer	Crab	Karka	Praesepe
23	Gemini	Twins	Mithuna	Castor, Pollux
24	Taurus	Bull	Vṛṣabha	Aldebaran, Pleiades, M1
25	Aries	Ram	Meṣa	Hamal
26	Pisces	Fishes	Mīna	
27	Pegasus	Pegasus	Mahāśva	Markab, Sheat
28	Vulpecula	Fox	Jambūka	

Map 2 showing, Constellations and their representative but imaginary Figures, on both sides of the Celestial Equator from Hour Angles XXIV to XI

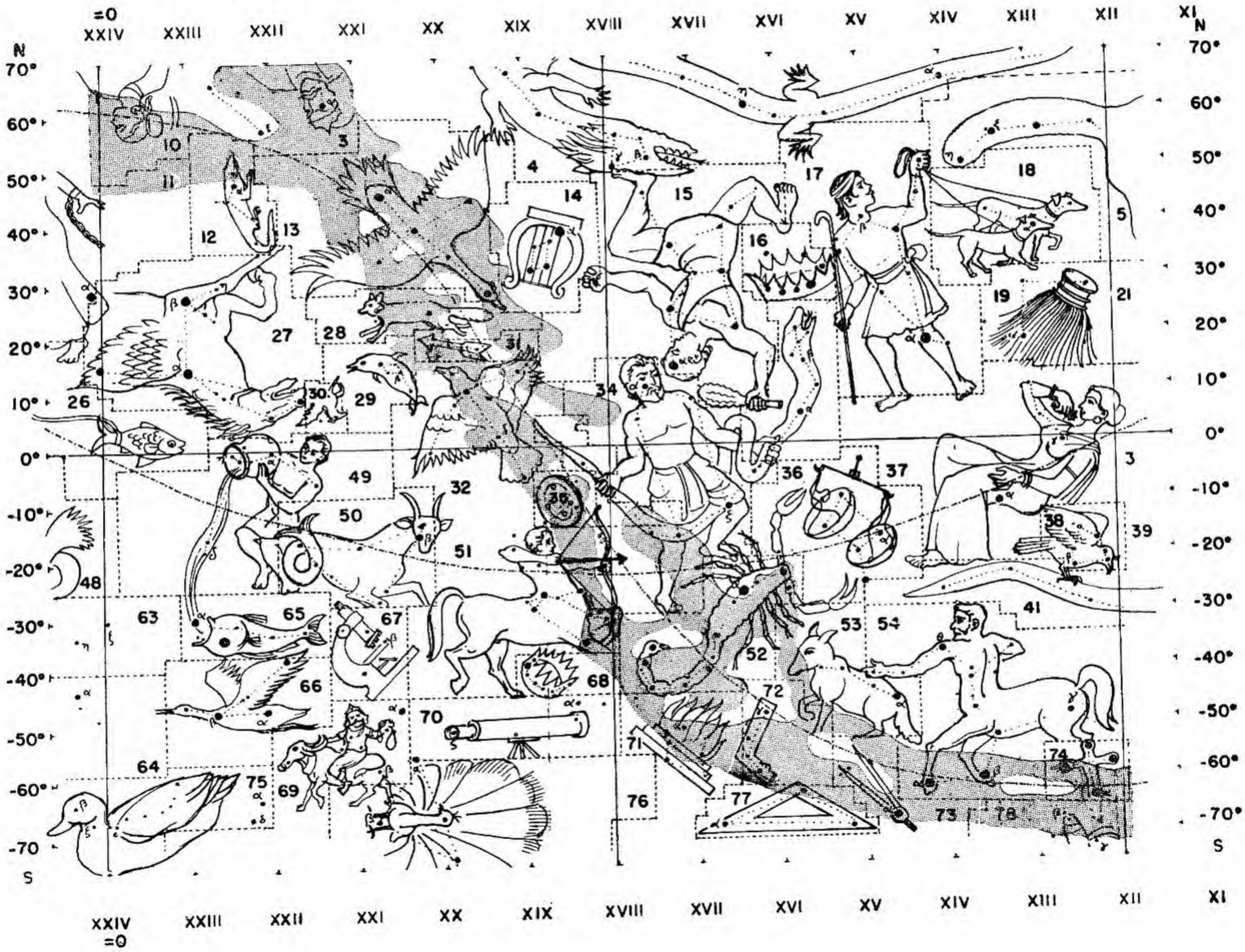

Table 2 showing, with reference to the Map 2, International Names of Constellations, their Indian and English equivalents along with some prominent features.

Sr. No.	International name	English name	India name	Prominent features
3	Cepheus	12 Lacerta		
4	Draco	13 Cygnus	For these items	
10	Cassiopeia	14 Lyra	please see Table 1	
11	Andromeda	15 Hercules		
16	Corona Borealis	Northern Crown	Uttara Mukuta	Gemma
17	Boötes	Herdsman	Bhūtapa	Arcturus
18	Canes Venatici	Hunting Dogs	Śyamaśabala	Cor Caroli, M 57
19	Coma Berenices	Berenices Hair	Arundhatī Keśa	
27	Pegasus	Pegasus	Mahāśva	
28	Vulpecula	Fox	Jambūka	
29	Delphinus	Dolphin	Dhanisthā	
30	Equuleus	Little Horse	Laghu Aśva	
31	Sagitta	Arrow	Śara	
32	Aquila	Eagle	Garūda	
33	Serpens	Serpent	Bhujaṅga	Altair
34	Eiuchus	Serpent Bearer	Bhujaṅgadhārī	Ras al Haque
35	Scutum	Shield	Phalaka	M 16
36	Libra	Scales	Tula	
37	Virgo	Virgin	Kanya	Spica
38	Corvus	Crow	Hasta	
41	Hydra	Water Serpent	Vāsukī	Alphard
48	Cetus	Whale	Timiṅgala	Mira
49	Aquarius	Water Bearer	Kumbha	
50	Capricornus	Sea Goat	Makara	Centre of Galaxy
51	Sagittarius	Archer	Dhanu	
52	Scorpius	Scorpion	Vṛśscika	Antares
53	Lupus	Wolf	Vṛka	
54	Centaurus	Centaur	Naraturaga	Proxima Centaurus
62	Scupltor	Sculptor	Śilpagar	
64	Phoenix	Phoenix	Jātayū	
65	Pisces Austrinus	Southern Fish	Dakṣiṇa matsya	Fomalhaut
66	Grus	Crane	Baka	
67	Microscopium	Microscope	Sūkṣma-darśaka	
68	Corona Australis	Southern Crown	Dakṣhīna Mukuta	
69	Indus	Indian	Yama	
70	Telescopium	Telescope	Durbīna	
71	Ara	75 Tucana		
72	Norma	76 Pavo	For these items	
73	Circinus	77 Triangulum Austr.	please see Table 4	
74	Crux	78 Musca		

Map 3 showing, Constellations and their representative but imaginary Figures on both sides of the Celestial Equator From Hour Angles XIII to XXIII

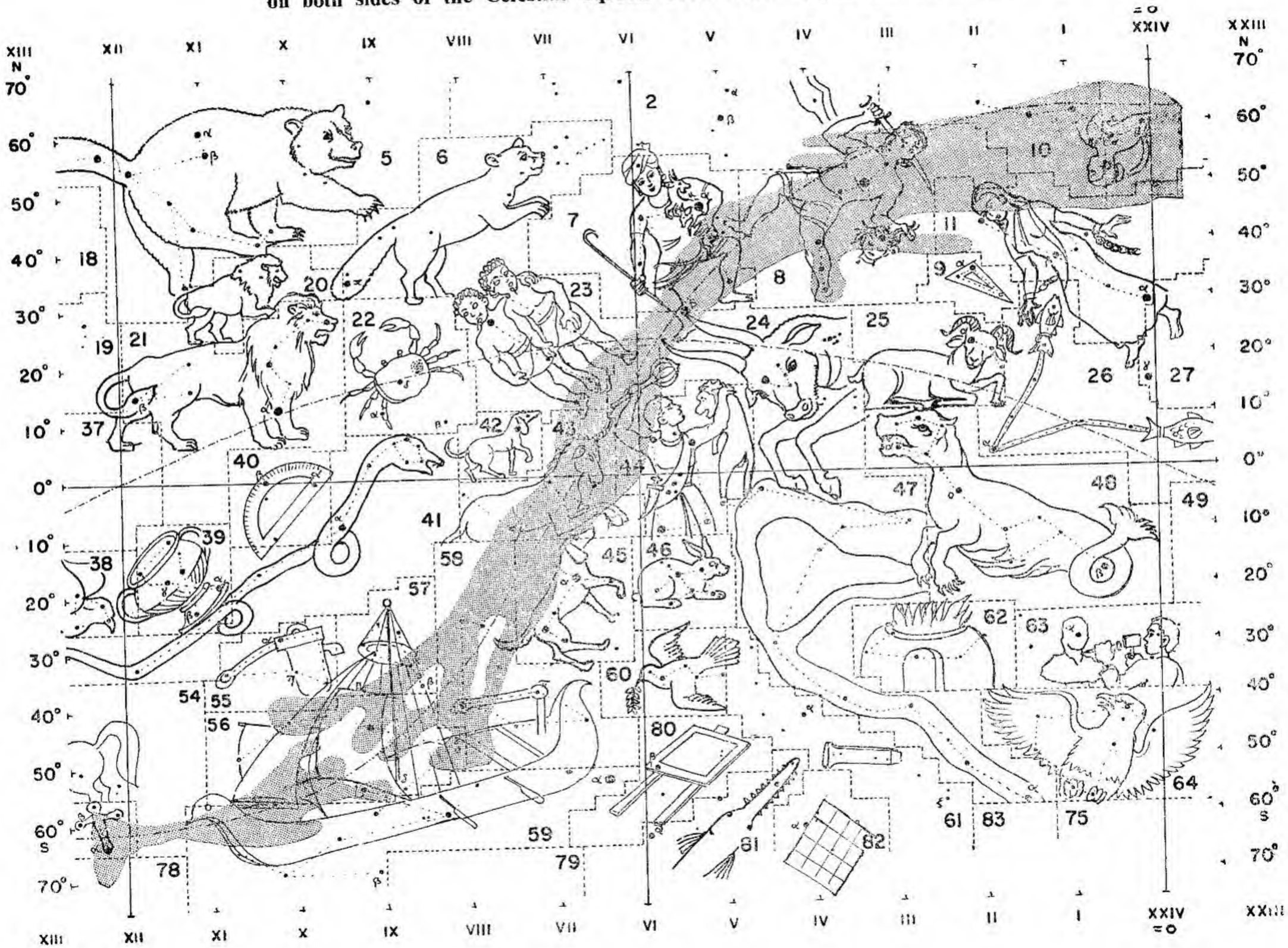

Table 3 showing, with reference to the Map 3, International Names of Constellations, their Indian and English equivalents along with some prominent features.

Sr. No.	International name	English name	Indian name	Prominent features
2	Camelopardus	9 Triangulum Bor.		
5	Ursa Major	10 Cassiopeia		For these items
6	Lynx	11 Andromeda		please see Table 1
7	Auriga	18 Canes		
8	Perseus	19 Coma		
20	Leo Minor	Little Lion	Laghu Simha	
21	Leo	Lion	Simha	Regulus, Denebola
22	Cancer	Crab	Karka	Praesepe
23	Gemini	Twins	Mithuna	Castor, Pollux
24	Taurus	Bull	Vṛṣabha	Aldebaran, Pleiades, M 1
25	Aries	Ram	Meṣa	Hamal
26	Pisces	Fishes	Mīna	Piscium
27	Pegasus	Pegasus	Mahāśva	Markab, Sheat
45	Canis Major	Great Dog	Bṛhallubdhaka	Sirius
46	Lepus	Hare	Śaśaka	
47	Eridanus	Eridanus	Yamunā	Achernar
48	Cetus	Whale	Timiṅgala	Mira
49	Aquarius	Water Bearer	Kumbha	
50	Capricornus	Sea Goat	Makara	
51	Sagittarius	Archer	Dhanu	Centre of Galaxy
52	Scorpius	Scorpion	Vṛścika	Antares
53	Lupus	Wolf	Vṛka	
54	Centaurus	Centaur	Nara-turaga	Proxima Centaurus
55	Antlia	Air Pump	Vātākarṣa	
56	Vela	Sails	Nauśīrsa	
57	Pyxis	Mariner's Compass	Digdarśika	
58	Puppis	Poop	Aritra	
59	Carina	Keel	Naukātala	Canopus
60	Columba	Dove	Pārāvata	
61	Caelum	Chisel		
62	Fornax	Furnace		
63	Sculptor	Sculptor		
64	Phoenix	80 Pictor		
74	Crux	81 Dorado		For these items
75	Tucana	82 Reticulum		please see Table 4
78	Musca	83 Hydrus		
79	Volans			

Map 4 showing Constellations and their representative but imaginary Figures Around the South Celestial Pole (clockwise)

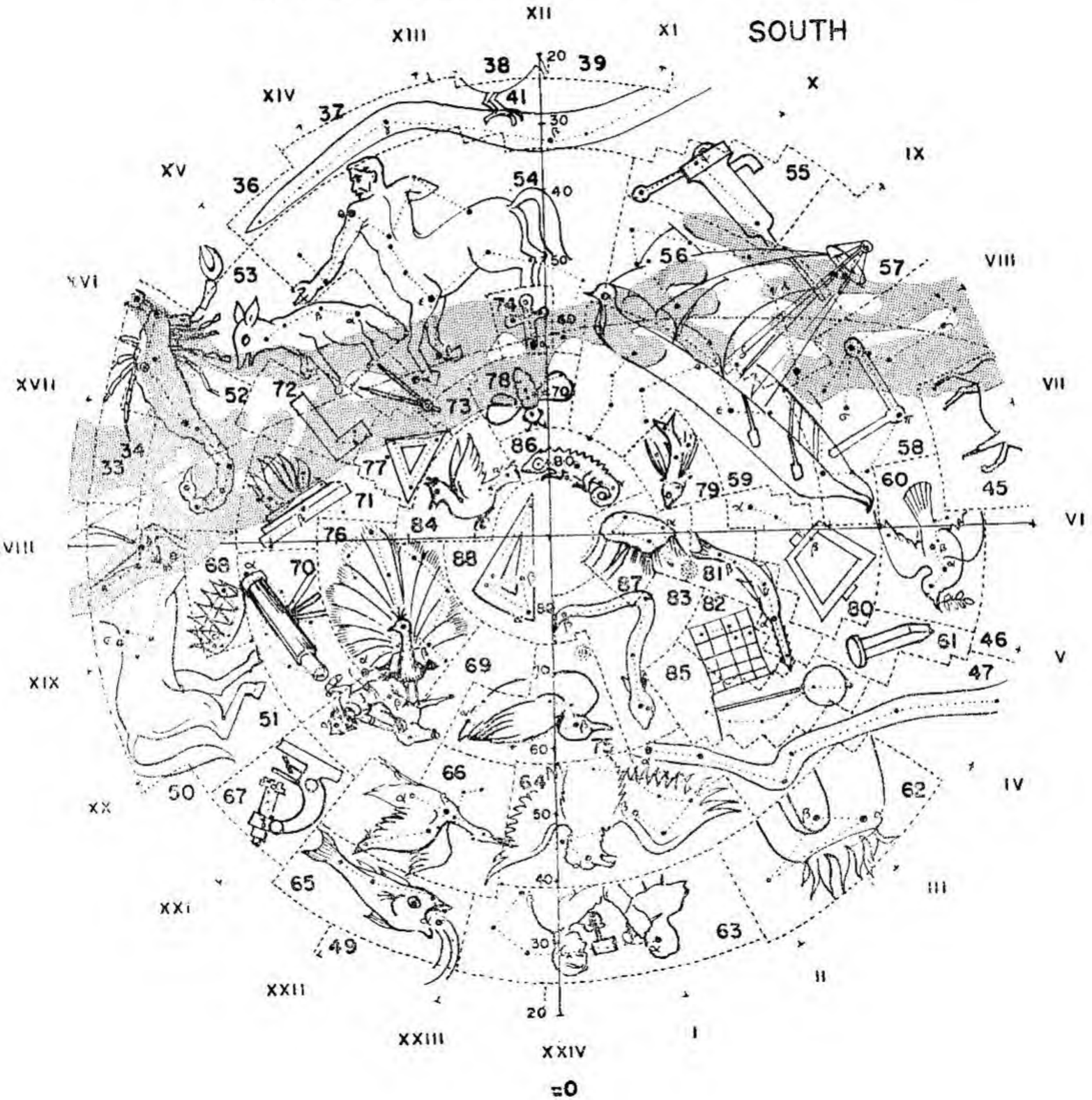

Table 4 showing, with reference to the Map 4, International Names of Constellations, their Indian and English equivalents along with some prominent features.

Sr. No.	International name	English name	Indian name	Prominent features
33	Serpens	Serpent	Bhujaṅga	
34	Ophiuchus	Serpent Bearer	Bhujaṅga dhārī	Ras al Hague
35	Scutum	Shield	Phalaka	M 16
36	Libra	Scales	Tulā	
37	Virgo	Virgin	Kanyā	Spica
38	Corvus	Crow	Hasta	
39	Crater	Cup	Caṣaka	
40	Sextans	Sextant	Ṣadamśa	
42	Canis Minor	Little Dog	Laghu lubdhaka	Procyon
43	Monoceros	Unicorn	Śṛṅgāśva	
44	Orion	Orion	Mṛga	Betelgeuse, Rigel, M42
45	Canis Major	Grea Dog.	Bṛhallubdhka	Sirius
46	Lepus	Hare	Śaśaka	
47	Eridanus	Eridanus	Yamunā	Achernar
48	Cetus	Whale	Timiṅgal	Mira
49	Aquarius	Water Bearer	Kumbha	
51	Sagittrius	Archer	Dhanu	Centre of Galaxy
54	Centaurus	Centaur	Nara turanga	Proxima Centaurus
55	Antlia	Air Pump	Vātākarṣa	
56	Vela	Sails	Naurśīrṣa	
57	Pyxis	Mariner's Compass	Digdarśaka	
58	Puppis	Poop	Aritra	
59	Carina	Keel	Naukātala	Canopus
60	Columba	Dove	Pārāvata	
61	Caelum	Chisel		
62	Fornax	Furnace	Aśmanta	
63	Sculptor	Sculptor	Śilpagāra	
64	Phoenix	Phoenix	Jatāyū	
65	Pisces Austr.	Southern Fish	Daksiṇa Matsya	Fomalhaut
66	Grus	Crane	Baka	
67	Microscopoum	Microscope	Sukṣmadarśaka	
68	Corona Austr.	Southern Crown	Daksina Mukuta	
69	Indus	Indian	Yama	
70	Telescopium	Telescope	Durbiṇa	
71	Ara	Altar	Pītha	
72	Norma	Square	Ankanī	
74	Crux	Southern Cross	Triśanku	Coal Sac
75	Tucana	Taucan	Kāraṇdava	Small Magellanic Clouds
76	Pavo	Peacock	Mayūra	
77	Triangulum Austr.	Suthern Triangle	Dakṣina trikoṇa	
78	Musca	Fly	Makṣikā	
79	Volans	Flying Fish	Śapharī	
80	Pictor	Painter	Citra phalaka	
81	Dorado	Sword Fish	Asidamṣtra	Large Magellanic Clouds
82	Reticulum	Net	Jālaka	
83	Hydrus	Water Snake	Alagarda	
84	Apus	Bird of Paradise	Kapota	
85	Horologium	Clock	Kālayantra	
86	Chameleon	Chameleon	Vāyubhakṣa	
87	Mensa	Table Mountain	Trikūta	
88	Octans	Octant	Aṣtaka	

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